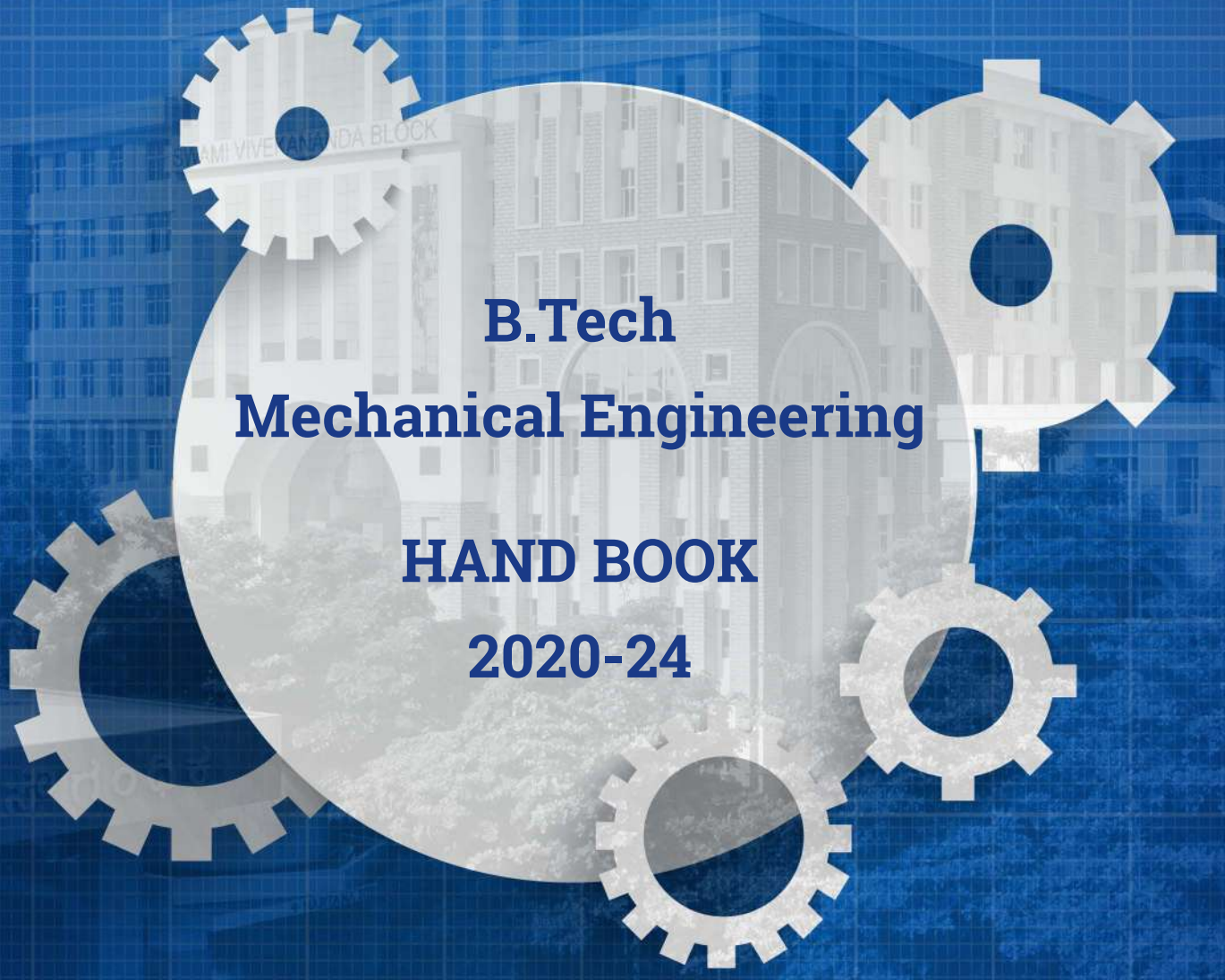
11 YEARS OF UNIVERSITY RECOGNITION

21 YEARS OF ACADEMIC EXCELLENCE

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING



B.Tech
Mechanical Engineering

HAND BOOK
2020-24

RUKMINI EDUCATIONAL
Charitable Trust

www.reva.edu.in

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING

HANDBOOK

B. Tech. in Mechanical Engineering

2020 Scheme

Applicable for 2020-24 Batch

Rukmini Knowledge Park,
Kattigenahalli, Yelahanka, Bangalore - 560 064
Phone No: +91-080-66226622, Fax: 080-28478539

www.reva.edu.in

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Chancellor's Message

"Education is the most powerful weapon which you can use to change the world."

- Nelson Mandela.

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju
The Founder and Hon'ble Chancellor
REVA University

Pro-Chancellor's Message

REVA University is most sought-after destination for higher education in the major streams of engineering, science, commerce, management, architecture, law, arts and humanities. University practices modern tools and ICT based technologies that focus on digital learning, project-based learning, personalized learning, etc. Educational reforms are adopted in terms of STEM education, teacher professional development with good mix of diversity and inclusivity.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. CBCS courses also provide knowledge on local, regional, national and global level issues along with enabling them to be employable and also aid to inculcate entrepreneurial skills across all the programs. Ample of opportunities are given for students to enhance their skill-sets through value added courses.

The current trends in engineering education engineering profession in the next two decades will undergo dramatic changes, driven by not only technological developments but also societal transformation. Besides increased globalization, more acute concern for environment for sustainable development will characterize changes and challenges for future engineers in their roles.

REVA University is fully prepared to all such challenges and ready for creating talented engineers and leaders. Such growth has been witnessed in terms of design and delivery of curriculum, student centric methods in teaching-learning, hands-on based practices through state-of-the-art laboratories and research centres and effective outreach activities with premiere industries and academic institutions. I thank all our students, parents, faculty, staff and well-wishers for their effort and contribution to take this university as one of next generation globally recognized education hub.

Mr. Umesh S Raju
Pro-Chancellor
REVA University

Vice Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of Reva University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these

programs. The entrepreneurship development activities and establishment of “Technology Incubation Centers” in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, “Intelligence plus character –that is the goal of education” (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavor to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating “GLOBAL PROFESSIONALS”.

Welcome to the portals of REVA University!

Dr. M. Dhanamjaya
Vice-Chancellor
REVA University

Director's Message

With great pleasure, I welcome you to the School of Mechanical Engineering at REVA University. The School offers Undergraduate programs in Mechanical Engineering, Mechatronics Engineering and Aerospace Engineering leading to B. Tech. Degree, in addition to Master's Program leading to M. Tech. Degree in Machine Design. More than 1500 students representing various parts of India as well a few students from overseas study at our School. The School has more than 60 well qualified and experienced faculty members. The School has modern teaching, learning, innovation and research facilities, in addition to excellent facilities for recreation and sports. Students are encouraged to live on campus to have better campus experience and our hostel facilities are second to none.

We understand that the students come to university for learning and the School focuses on enhancing the efficiency of learning of students and also achieving the learning outcomes to pursue careers in modern day industries. To improve efficiency of learning the School has successfully adopted modern day pedagogical methods like project based learning, problem based learning, blended learning, flipped class rooms, experiential learning and created digital resources for students to access and experience. The faculty members of the School continuously upgrade their pedagogical methods and knowledge to be in par with the best in the Country. Our students are very successful in developing and demonstrating technologically advanced projects during their final year.

Our masters and PhD Scholars work on scientifically and technologically advanced topics in mechanical design, engineering analysis, manufacturing of mechanical and mechatronic systems and publish their research findings in international journals of repute.

The curriculum caters to and has relevance to Local, Regional, National, Global developmental needs. Maximum number of courses are integrated with cross cutting issues with relevant to Professional ethics, Gender, Human Values, Environment and Sustainability.

The School has created an excellent ambience conducive for innovation, creativity and interaction. Faculty mentors and senior students instill confidence in the junior students and motivate them to achieve higher goals. The students are given support for their industry internship, placements, study abroad, industry projects and interaction with industry mentors.

I welcome you to our School and I am sure your learning experience at our school will be an enjoying and memorable one.

Dr. K.S. Narayanaswamy
Director

RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. **Rukmini Educational Charitable Trust** (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 13,000 students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette No. 80 dated 27thFebruary, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 50 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer centre, the well planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 41 Undergraduate Programmes, 31 Postgraduate Programmes, 18 Ph. D Programmes, and 4 Certificate/ Diploma/Postgraduate Diploma Programmes in various disciplines.

The curriculum of each programme is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered into MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fluid Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor& Dean, and supported by well experienced Trainers, Counselors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC^2, VMware, SAP, Apollo etc., to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division

headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defense Dr. Sathish Reddy, Scientific Advisor, Ministry of Defense, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

REVA organizes various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVOTSAVA conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognized by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga class's every day to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Vision of REVA University

REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards

Mission of REVA University

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centers
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives of REVA University

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines
- Smooth transition from teacher - centric focus to learner - centric processes and activities
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner

ABOUT SCHOOL OF MECHANICAL ENGINEERING

Mechanical Engineering is one of the oldest and classical branches of engineering which drives the development and economy of the country .The school of Mechanical Engineering in REVA University has a rich blend of experienced, energetic and dedicated faculty with highest qualification in the specialization of thermal, design, manufacturing and management streams. The school is having well-furnished class rooms and well equipped laboratories with modern software tools to meet academic and industry requirements. The research Centre with modern equipment's and testing facility is also available to cater research activities in the field of materials and bio-fuels. The school is conducting extracurricular and co-curricular activities to develop additional skills, knowledge and confidence through University Industry Interaction Cell and various student clubs and student chapters with the support of industries. Industry persons are invited to give technical talks on latest technologies and students are deputed for internship in industries and universities in India and Abroad. The school is having MOU with reputed industries and universities in India and abroad for internship, research and twinning program or higher studies which will give more exposure of our students to outside world. Many students have done internship in reputed institutions like IISc, ISRO, DRDO, HAL, Rail Wheel factory, Volvo and many more. Every semester school is organizing industry visits to reputed institutions to learn various aspects of industry. The school is having clubs and chapters which are MARS, ISHRAE Student Chapter, Foundry man Society, Fluid Power Society, Solar Society, Tribology society, Robotics club, SAE club and Aryan Racing Team through which cultural events, training programs, invited talks, industry visits and placement activities are conducting. School is encouraging the students to participate in national and international level competitions like solar car design, Electric vehicle design, Formula car design, ATV design, Go-Cart design and quiz competition through this student can learn additional skills like design, team management, time management and financial aspects. Additional training programs are conducting in the field of automobile, robotics, and manufacturing to impart skills with industry relevant. The School is organizing workshops, seminars, conferences and competitions in national and international level for the students, faculty and research scholars to enhance their skills and research trends. The school offers B.Tech in Mechanical Engineering, B.Tech in Mechatronics Engineering, B.Tech Aerospace Engineering, M.Tech in Machine design and PhD program. The curriculum of both UG and PG is designed to meet the needs of the society and industry for present and future. It also meets the requirements of higher studies in India and abroad and also for the requirement of competitive exams. In overall, school will support and make our students more disciplined, good human being and more responsible persons of the society.

Vision of School of Mechanical Engineering

"Aspires to be recognized globally for outstanding value based education in mechanical and allied areas and research leading to well-qualified engineers, who are innovative, entrepreneurial, successful in their career and committed to the development of the country."

Mission of School of Mechanical Engineering

- To impart quality education to the students and enhance their skills to make them globally competitive engineers in mechanical and allied areas.
- To promote multidisciplinary study, cutting edge research and expand the frontiers of engineers' profession in mechanical and allied areas.
- To create state-of-art facilities with advanced technology for providing students and faculty with opportunities for innovation, application and dissemination of knowledge.
- To prepare for critical uncertainties ahead for mechanical engineering and allied areas and to face the challenges through clean, green and healthy solution.
- To collaborate with industries, institutions and such other agencies nationally and internationally to undertake exchange programs, research, consultancy and to facilitate students and faculty with greater opportunities for individual and societal growth.

ADVISORY BOARD OF SCHOOL OF MECHANICAL ENGINEERING

Sl. No.	Details of Members
1	**Dr. N. V. Ravikumar,** Associate Professor, Department of Metallurgy & Materials Engineering, IIT Madras, Chennai.
2	**Mr. K. N. Narsimha Murthy** Chairman, Fluid Air Systems, Bengaluru. Hon. Treasurer, Karnataka Small Scale Industries Association (KSSIA)
3	**Prof. M. V. Krishna Murthy** Former Professor, Dept. Mechanical Engineering, IIT Madras, Chennai, Former Director, VIT, Vellore.
4	**Mr. Praveen Kumar Jinde,** Scientist, NAL, Bengaluru.
5	**Dr. K Ramachandra** Former Director, GTRE, Bangalore CEO, NP-MICAV's National Design Research Forum The Institute of Engineers, Bengaluru.
6	**Prof. E. Abhilash** Dept. Mechanical Engineering, King Khalid University Abha, Kingdom of Saudi Arabia.

Program Overview

Mechanical Engineering is a discipline of engineering that applies the principles of physics and materials science for design, analysis, prototyping, manufacturing, and maintenance of mechanical systems. Mechanical engineering deals with inter conversion of thermal and mechanical power and the design, production, and operation of machines and tools. It is one of the oldest and broadest engineering disciplines.

The mechanical engineering field requires an understanding of core concepts including mechanics, kinematics, thermodynamics, materials science, and structural analysis. Mechanical engineers use these core principles along with tools like computer-aided engineering and product lifecycle management to design and analyze manufacturing plants, industrial equipment and machinery, heating and cooling systems, transport systems, aircraft, watercraft, robotics, medical devices and more.

Mechanical Engineering science emerged in the 19th century as a result of developments in the field of physics. The field has continually evolved to incorporate advancements in technology. Mechanical engineers today are pursuing developments in fields such as composites, mechatronics and micro and nano technology. Mechanical Engineering overlaps with aerospace engineering, civil engineering, electrical engineering, petroleum engineering and chemical engineering to varying amounts.

There is tremendous scope for mechanical engineers in automobile engineering, cement industry, steel, power sector, hydraulics, manufacturing plants, drilling and mining industry, petroleum, aeronautical, biotechnology and many more. Nowadays they are also increasingly needed in the environmental and bio-medical fields. There are exciting times ahead for mechanical engineers as transport technologies like hyper loop, electric vehicles, flying cars, drone technologies, intelligent system like robots and additive manufacturing including 3D printing are gaining importance.

A beginner in Mechanical Engineering can opt for various job openings such as: Design Engineer, CAE Analyst, Shop Floor Engineer, Production Planning, Quality Assurance, Maintenance Engineer, Safety Engineer, Production Supervisor/Engineer, R&D Trainee etc.

The School of Mechanical Engineering at REVA UNIVERSITY offers B. Tech., Mechanical Engineering– an undergraduate programme to create motivated, innovative, creative and thinking graduates to fill the roles of Mechanical Engineers who can conceptualize, design, analyse, develop and produce Mechanical Systems to meet the modern day requirements.

The B. Tech., in Mechanical Engineering curriculum developed by the faculty at the School of Mechanical Engineering, is outcome based and it comprises required theoretical concepts and practical skills in the domain. By undergoing this programme, students develop critical, innovative, creative thinking and problem solving abilities for a smooth transition from academic to real-life work environment. In addition, students are trained in interdisciplinary topics and attitudinal skills to enhance their scope. The above mentioned features of the programme, advanced teaching and learning resources, and experience of the faculty members with their strong connections with manufacturing sector makes this programme unique.

Program Educational Objectives (PEO's)

The After few years of graduation, the graduates of B.Tech Mechanical Engineering will:

- **PEO1:** Design, develop, maintain and improve mechanical engineering systems with highest quality, economically feasible and socially acceptable.
- **PEO2:** Exhibit analytical, computational and experimental skills to address the challenges faced in mechanical and allied engineering streams.
- **PEO3:** Exhibit professionalism, ethical attitude, team spirit and communication skill and pursue lifelong learning to achieve career goals, organizational goals and societal goals.

Program Outcomes (POs)

On successful completion of the program, the graduates of B.Tech Mechanical Engineering will be able to:

- **PO1: Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, to solve mechanical engineering problems.
- **PO2: Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- **PO3: Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO4: Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems
- **PO5: Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- **PO6: The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **PO7: Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **PO8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **PO9: Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO11: Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

- **PO12: Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

On successful completion of the program, the graduates of B.Tech Mechanical Engineering will be able to:

- **PSO1:** Demonstrate mechanical and interdisciplinary knowledge to analyse, design and manufacture products to address the needs of the society for sustainable growth.
- **PSO2:** Use state of the art tools and techniques to conceptualize, design and develop new products, sustenance of legacy products, processes, systems and services.
- **PSO3:** Communicate effectively as well as to adopt a realistic, practical, systematic and innovative approach to problem solving as a team.

REVA University Academic Regulations
B. Tech., (4 years) Degree Programs
(Applicable for the programs offered from 2020-21)

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

(Framed as per the provisions under Section 35 (ii), Section 7 (x) and Section 8 (xvi) & (xxi) of the REVA University Act, 2012)

1. Title and Commencement:

1.1 These Regulations shall be called **"REVA University Academic Regulations – B. Tech., Degree Program 2020-21 Batch subject to amendments from time to time by the Academic Council on recommendation of respective Board of Studies and approval of Board of Management**

1.2 These Regulations shall come into force from the date of assent of the Chancellor.

2. The Programs:

These regulations cover the following B. Tech., Degree programs of REVA University offered during 2019-20

B Tech in:

Bioelectronics Engineering
Civil Engineering
Computer Science and Engineering
Computer Science and Information Technology
Computer Science and Systems Engineering
Computer Science and Engineering (AI and ML)
Electrical and Electronics Engineering
Electrical and Computer Engineering
Electronics and Communication Engineering
Electronics and Computer Engineering
Information Science and Engineering
Mechanical Engineering
Mechatronics Engineering

3. Duration and Medium of Instructions:

3.1 Duration: The duration of the B Tech degree program shall be FOUR years comprising of **EIGHT** Semesters. A candidate can avail a maximum of 16 semesters - 8 years as per double duration norm, in one stretch to complete B. Tech degree, including blank semesters, if any. Whenever a candidate opts for blank semester, he/she has to study the prevailing courses offered by the School when he/she resumes his/her studies.

3.2 The medium of instruction shall be English.

4. Definitions:

4.1 Course: "Course" means a subject, either theory or practical or both, listed under a programme; Example: "Fluid Mechanics" in B Tech Civil Engineering program, Engineering Thermodynamics in B. Tech., Mechanical program are examples of courses to be studied under respective programs.

Every course offered will have three components associated with the teaching-learning process of the course, namely:

L	**Lecture**
T	**Tutorial**
P	**Practice**

Where:

L stands for **Lecture** session consisting of classroom instruction.
T stands for **Tutorial** session consisting participatory discussion / self-study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.
P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies / Project Based Learning or Course end Project/Self Study/ Online courses from listed portals that equip students to acquire the much required skill component.

4.2 Classification of Courses

Courses offered are classified as: Core Courses, Open Elective Courses, Project work/Dissertation

4.2.1 **Core Course:** A course which should compulsorily be studied by a candidate choosing a particular program of study

4.2.2 **Foundation Course:** The foundation Course is a mandatory course which should be completed successfully as a part of graduate degree program irrespective of the program of study

4.2.3 **Hard Core Course (HC) simply core course:** The **Hard Core Course** is a Core Course in the main branch of study and related branch(es) of study, if any, that the candidates have to complete compulsorily

4.2.4 **Soft Core Course (SC) (also known as Professional Elective Course)**
A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study

4.2.5 **Open Elective Course (OE):**
An elective course chosen generally from other discipline / subject, with an intention to seek exposure to the basics of subjects other than the main discipline the student is studying is called an **Open Elective Course**

4.2.6 **Project Work / Dissertation:**
Project work / Dissertation work is a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problems to solve a multivariable or complex engineering problems. The project will be conducted in two phases, phase-I (7th Semester), Consists of literature survey, problem identification, formulation and methodology. In Phase-II (8th Semester) student should complete the project work by designing or creating an innovative process or development of product as an outcome. A project work carrying **TWO**, **FOUR or SIX** credits is called Minor Project work / Dissertation. A project work of **SIX, EIGHT, or TEN,** credits is called Major Project work / Dissertation. **A Minor Project work may be a hard core or a Soft Core as decided by the BOS / concerned. But the Major Project shall be Hard Core.**

4.2.7 **"Program"** means the academic program leading to a Degree, Post Graduate Degree, Post Graduate Diploma Degree or such other degrees instituted and introduced in REVA University.

5. Eligibility for Admission:

5.1. The eligibility criteria for admission to B Tech Program of 4 years (8 Semesters) is given below:

Sl. No.	Program	Duration	Eligibility
1	Bachelor of Technology (B Tech)	4 Years (8 Semesters)	Passed 10+2 examination with Physics and Mathematics as compulsory subjects, along with any one of the following subjects, namely, Chemistry, Bio-Technology, Computer Science, Biology, Electronics and Technical Vocational subject Obtained at least 45% marks (40% in case of candidate belonging to SC/ST category) in the above subjects taken together.
2	Bachelor of Technology (B Tech)	Lateral entry to second year	A. Passed Diploma examination from an AICTE approved Institution with at least 45% marks (40% in case of candidates belonging to SC/ST category) in appropriate branch of Engineering / Technology. B. Passed B. Sc Degree from a recognized University as defined by UGC, with at least 45% marks (40% in case of candidates belonging to SC/ST category) and passed XII standard with mathematics as a subject. C. Provided that in case of students belonging to B. Sc. Stream, shall clear the subjects of Engineering Graphics / Engineering Drawing and Engineering Mechanics of the first year Engineering program along with the second year subjects. D. Provided further that, the students belonging to B. Sc. Stream shall be considered only after filling the seats in this category with students belonging to the Diploma stream. E. Provided further that student, who have passed Diploma in Engineering & Technology from an AICTE approved Institution or B. Sc., Degree from a recognized University as defined by UGC, shall also be eligible for admission to the first year Engineering Degree courses subject to vacancies in the first year class in case the vacancies at lateral entry are exhausted. However the admissions shall be based strictly on the eligibility criteria as mentioned in A, B, D, and E above.
	Bachelor of Technology (B Tech)	Lateral entry to fourth year	Any candidate with genuine reason from any University / Institution in the country upon credit transfer could be considered for lateral admission to the respective

Sl. No.	Program	Duration	Eligibility
		(final year)	semester in the concerned branch of study, provided he/she fulfils the University requirements.
4	B. Tech. in Bioelectronics		Pass in PUC / 10+2 examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry / Biotechnology / Biology / Computer Science / Electronics / Technical Vocational subjects and obtained minimum 45% marks (40% in case of candidates belonging to SC / ST category) in the above subjects taken together of any board recognized by the respective State Government / Central Government / Union Territories or any other qualification recognized as equivalent there to.

5.2 Provided further that the eligibility criteria are subject to revision by the Government Statutory Bodies, such as AICTE, UGC from time to time.

6. Courses of Study and Credits

6.1 Each course of study is assigned with certain credit value

6.2 Each semester is for a total duration of 20 weeks out of which 16 weeks dedicated for teaching and learning and the remaining 4 weeks for final examination, evaluation and announcement of results

6.3 The credit hours defined as below:

In terms of credits, every one hour session of L amounts to 1 credit per Semester and a minimum of two hour session of T or P amounts to 1 credit per Semester or a three hour session of T / P amounts to 2 credits over a period of one Semester of 16 weeks for teaching-learning process.

1 credit = 13 credit hours spread over 16 weeks or spread over the semester

The total duration of a semester is 20 weeks inclusive of semester-end examination.

The following table describes credit pattern

Table -2: Credit Pattern

Lectures (L)	Tutorials (T)	Practice (P)	Credits (L:T:P)	Total Credits	Total Contact Hours
4	2	0	4:1:0	5	6
3	2	0	3:1:0	4	5
3	0	2	3:0:1	4	5
2	2	2	2:1:1	4	6
0	0	6	0:0:3	3	6
4	0	0	4:0:0	4	4

a. The concerned BoS will choose the convenient Credit Pattern for every course based on size and nature of the course

7. Different C**ourses of Study**:

Different C**ourses of Study** are labeled as follows:

a. Core Course (CC)
b. Foundation Course (FC)

c. Hard Core Course (HC)

d. Soft Core Course (SC)
e. Open Elective Course (OE)

f. Project Work / Dissertation:
g. A project work carrying **TWO, FOUR or SIX** credits is called Minor Project work / Dissertation. A project work of **EIGHT, TEN, TWELVE or SIXTEEN** credits is called Major Project work / Dissertation. A Project work may be a hard core or a Soft Core as decided by the BoS / concerned.

These are defined under Section 4 of these regulations.

8. Credits and Credit Distribution

8.1 A candidate has to earn 160 credits for successful completion of B Tech degree with the distribution of credits for different courses as given in table below:

Course Type	**Credits (Range)** **For B Tech Degree (8 Semesters)**
Foundation Core Course	A minimum of 06 but not exceeding 12
Hard Core Course	A minimum of 118 but not exceeding 121
Soft Core Course	A minimum of 15 but not exceeding 21
Open Elective	A minimum of 04 but not exceeding 12

8.2. The concerned BOS based on the credits distribution pattern given above shall prescribe the credits to various types of courses and shall assign title to every course including project work, practical work, field work, self-study elective, as **Foundation Course (FC), Hard Core (HC) or Soft Core (SC), Open Elective (OE).**

8.3. Every course including project work, practical work, field work, self-study elective should be entitled as **Foundation Course (FC), Hard Core (HC) or Soft Core (SC) or Open Elective (OE)** or **Core Course** (**CC**) by the BoS concerned. However, following shall be the **Foundation Courses** with credits mentioned against them, common to all branches of study.

Sl. No.	**Course Title**	**Number of Credits**
Foundation Courses		
1	English for Technical Communication / Communicative Skills	2-3
2	Environmental Studies / Environmental Sciences	2
3	Indian Constitution and Professional Ethics	2
4	MOOC / Internship /Soft Skill Training	6-15

8.4. The concerned BOS shall specify the desired Program Educational Objectives, Program Outcomes, Program Specific Outcomes and Course Outcomes while preparing the curriculum of a particular program.

8.5. A candidate can enrol for a maximum of 28 credits and a minimum of 19 credits per Semester. However he / she may not successfully earn a maximum of 28 credits per semester. This maximum of 28 credits does not include the credits of courses carried forward by a candidate.

8.6 Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to VIII semester and complete successfully 160 credits in 8 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities.

8.7 Add- on Proficiency Certification:

To acquire Add on Proficiency Certification a candidate can opt to complete a minimum of 4 extra credits either in the same discipline /subject or in different discipline / subject in excess to 160 credits for the B Tech Degree program**.**

8.7.1. Add on Proficiency Diploma / Minor degree/ Honor Degree:

To acquire Add on Proficiency Diploma/ Minor degree/ Honor Degree:, a candidate can opt to complete a minimum of 18 extra credits either in the same discipline /subject or in different discipline / subject in excess to 160 credits for the B Tech Degree program.

The Add on Proficiency Certification / Diploma/ Minor degree/ Honor Degree: so issued to the candidate contains the courses studied and grades earned.

9 Assessment and Evaluation

9.1 The Scheme of Assessment will have two parts, namely;

i. Internal Assessment (IA); and
ii. Semester End Examination (SEE)

9.2 Assessment and Evaluation of each Course shall be for 100 marks. The Internal Assessment (IA) and Semester End Examination (SEE) of UG Engineering programs shall carry 50:50 marks respectively (i.e., 50 marks internal assessment; 50 marks semester end examination).

9.3 The 50 marks of internal assessment shall comprise of:

Internal Test	**30 marks**
Assignments / Seminars / Model Making / Integrated Lab / Project Based Learning / Quizzes etc.	**20 marks**

9.4 There shall be **two Internal Tests** conducted as per the schedule announced below. **The Students' shall attend both the Tests compulsorily.**

- 1st test is conducted for 15 marks during **6th week** of the Semester;
- 2nd test is conducted for 15 marks during **12th week** of the of the Semester;

9.5 The coverage of syllabus for the said tests shall be as under:

- Question paper of the **1st test should be based on first 40 %of the total syllabus**;
- Question paper of the **2nd test should be based on second 40 %of the total syllabus**;
- An assignment must be designed to cover the last **20% of the Syllabus**

9.6 There shall be one Assignment / Project Based Learning / Field Visit / Quiz test carrying 20 marks covering the last 20% of the Syllabus

9.7 The Semester End Examination for 50 marks shall be held in the 18th and 19th week of the beginning of the semester and the syllabus for the semester end examination shall be entire syllabus.

9.8 A test paper is set for a maximum of 30 marks to be answered in 1 hour duration. A test paper can have 4 main questions. Each main question is set for 10 marks. The main question can have 2-3 sub questions all totalling 10 marks. Students are required to answer any three main questions. Each question is set using Bloom's verbs. The questions must be set to assess the course outcomes described in the course document even with the choice is given in question

9.9 The question papers for internal test shall be set by the internal teachers who have taught the course. If the course is taught by more than one teacher all the teachers together shall devise a common question paper(s). However, these question papers shall be scrutinized by the Question Paper Scrutiny Committee to bring in the uniformity in the question paper pattern and as well to maintain the necessary standards.

9.10 The evaluation of the answer scripts shall be done by the internal teachers who have taught the course and set the test paper.

9.11 Assignment/seminar/Project based learning/simulation based problem solving/field work should be set in such a way, students be able to apply the concepts learnt to a real life situation and students should be able to do some amount self-study and creative thinking. While setting assignment care should be taken such that the students will not be able to plagiarise the answer from web or any other resources. An assignment / Quiz can be set for a maximum of 20. Course instructor at his/her discretion can design the questions as a small group exercise or individual exercise. This should encourage collaborative learning and team learning and also self-study.

9.12 Internal assessment marks must be decided well before the commencement of Semester End examinations

9.13 Semester End Examination: The Semester End Examination is for 50 marks shall be held in the 18th and 19th week of the semester and the entire course syllabus must be covered while setting the question paper.

9.14 Semester End Examination paper is set for a maximum of 100 marks to be answered in 3 hours duration. Each main question be set for a maximum of 25 marks, main questions can have a 3-4 sub questions. A total of 8 questions are set so that students will have a choice. Each question is set using Bloom's verbs. The questions must be set to assess the students outcomes described in the course document. (Please note question papers have to be set to test the course outcomes)

9.15 There shall be three sets of question papers for the semester end examination of which one set along with scheme of examination shall be set by the external examiners and two sets along with scheme of examination shall be set by the internal examiners. All the three sets shall be scrutinized by the Board of Examiners. It shall be responsibility of the Board of Examiners particularly Chairman of the BOE to maintain the quality and standard of the question papers and as well the coverage of the entire syllabus of the course.

9.16 There shall be single evaluation by the internal teachers who have taught the subject. However, there shall be moderation by the external examiner. In such cases where sufficient number of external examiners are not available to serve as moderators internal senior faculty member shall be appointed as moderators.

9.17 Board of Examiners, question paper setters and any member of the staff connected with the examination are required to maintain integrity of the examination system and the quality of the question papers.

9.18 There shall also be an **Program Assessment Committee (PAC)** comprising at-least 3 faculty members having subject expertise who shall after completion of examination process and declaration of results review the results sheets, assess the performance level of the students, measure the attainment of

course outcomes, program outcomes and assess whether the program educational objectives are achieved and report to the Director of the School. The Examination Review Committee shall also review the question papers of both Internal Tests as well Semester End Examinations and submit reports to the Director of the respective School about the scope of the curriculum covered and quality of the questions.

9.19 The report provided by the Examination Review Committee shall be the input to the Board of Studies to review and revise the scheme of instruction and curriculum of respective program

9.20 During unforeseen situation like the Covid-19, the tests and examination schedules, pattern of question papers and weightage distribution may be designed as per the convenience and suggestions of the board of examiners in consultation with COE and VC

9.21 University may decide to use available modern technologies for writing the tests and SEE by the students instead of traditional pen and paper

9.22 Any deviations required to the above guidelines can be made with the written consent of the Vice Chancellor

9.23 Online courses may be offered as per UGC norms.

For online course assessment guidelines would be as follows:

1. If the assessment is done by the course provider, then the School can accept the marks awarded by the course provider and assign the grade as per REVA University norms.
2. If the assessment is not done by the course provider then the assessment is organized by the concerned school and the procedure explained in the regulation will apply
3. In case a student fails in an online course, s/he may be allowed to repeat the course and earn the required credits

IAs for online courses could be avoided and will remain at the discretion of the School.

9.24 The online platforms identified could be SWAYAM, NPTEL, Coursera, Edx.org, Udemy, Udacity and any other internationally recognized platforms like MIT online, Harvard online etc.

9.25 Utilization of one or two credit online courses would be:

4 week online course – 1 credit
8 week online course / MOOC – 2 credits
12 week online course / MOOC – 3 credits

9.26 **Summary of Internal Assessment, Semester End Examination and Evaluation** Schedule is provided in the table given below.

Summary of Internal Assessment and Evaluation Schedule

Sl. No.	Type of Assessment	when	Syllabus Covered	Max Marks	Reduced to	Date by which the process must be completed
1	Test-1	During 6th week	First 40%	30	15	7th week
2	Test -2	During 12th Week	Second 40%	30	15	13th Week
3	Assignment / Quiz	15th Week	Last 20%	20	20	16th Week
4	SEE	18/19th Week	100%	100	50	20th Week

10 Assessment of Students Performance in Practical Courses

The performance in the practice tasks / experiments shall be assessed on the basis of:

a) Knowledge of relevant processes;

b) Skills and operations involved;

c) Results / products including calculation and reporting.

10.1 The 50 marks meant for Internal Assessment (IA) of the performance in carrying out practical shall further be allocated as under:

i	Conduction of regular practical / experiments throughout the semester	20 marks
ii	Maintenance of lab records	10 marks
iii	Performance of mid-term test (to be conducted while conducting second test for theory courses); the performance assessments of the mid-term test includes performance in the conduction of experiment and write up about the experiment.	20 marks
	Total	**50 marks**

10.2 The 50 marks meant for Semester End Examination (SEE), shall be allocated as under:

i	Conducting of semester end practical examination	30 marks
ii	Write up about the experiment / practical conducted	10 marks
iii	Viva Voce	10 marks
	Total	**50 marks**

10.3 The duration for semester-end practical examination shall be decided by the concerned School Board. For MOOC and Online Courses assessment shall be decided by the BOS of the School.

For > 3 credit courses

i	IA-I	25 marks
ii	IA-2	25 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc.)	50 marks
	Total	**100 marks**

For 1 & 2 credit courses

i	IA	25 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc.)	25 marks
	Total	**50 marks**

11. Evaluation of Minor Project / Major Project / Dissertation:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

Component – I	Periodic Progress and Progress Reports (25%)
Component – II	Demonstration and Presentation of work (25%)
Component – III	Evaluation of Report (50%)

12. Requirements to Pass a Course:

A candidate's performance from IA and SEE will be in terms of scores, and the sum of IA and SEE scores will be for a maximum of 100 marks (IA = 50 , SEE = 50) and have to secure a minimum of 40% to declare pass

in the course. However, a candidate has to secure a minimum of 25% (13 marks) in Semester End Examination (SEE) which is compulsory.

The Grade and the Grade Point: The Grade and the Grade Point earned by the candidate in the subject will be as given below:

Marks, P	Grade, G	Grade Point (GP=V x G)	Letter Grade
90-100	10	v*10	O
80-89	9	v*9	A+
70-79	8	v*8	A
60-69	7	v*7	B+
55-59	6	v*6	B
50-54	5.5	v*5.5	C+
40-49	5	v*5	C
0-39	0	v*0	F
ABSENT			AB

O - Outstanding; A+-Excellent; A-Very Good; B+-Good; B-Above Average; C+-Average; C-Satisfactory; F – Unsatisfactory.

Here, P is the percentage of marks (P=[IA + SEE]) secured by a candidate in a course which is **rounded to nearest integer**. V is the credit value of course. G is the grade and GP is the grade point.

a. Computation of SGPA and CGPA

The Following procedure to compute the Semester Grade Point Average (SGPA).

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in a given semester, i.e : **SGPA (Si) = ∑(Ci x Gi) / ∑Ci** where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course 1	3	A+	9	3X9=27
Course 2	3	A	8	3X8=24
Course 3	3	B+	7	3X7=21
Course 4	4	O	10	4X10=40
Course 5	1	C	5	1X5=5
Course 6	2	B	6	2X6=12
Course 7	3	O	10	3X10=30
	19			159

Thus, **SGPA = 159 ÷ 19 = 8.37**

Illustration No. 2

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade point)

Course 1	4	A	8	4X8=32
Course 2	4	B+	7	4X7=28
Course 3	3	A+	9	3X9=27
Course 4	3	B+	7	3X7=21
Course 5	3	B	6	3X6=18
Course 6	3	C	5	3X5=15
Course 7	2	B+	7	2X7=21
Course 8	2	O	10	2X10=20
	24			175

Thus, SGPA = 175 ÷ 24 = 7.29

Illustration No.3

Course	**Credit**	**Grade Letter**	**Grade Point**	**Credit Point (Credit x Grade point)**
Course 1	4	O	10	4 x 10 = 40
Course 2	4	A+	9	4 x 9 = 36
Course 3	3	B+	7	3 x 7 = 21
Course 4	3	B	6	3 x 6 = 18
Course 5	3	A+	9	3 x 9 = 27
Course 6	3	B+	7	3 x 7 = 21
Course 7	2	A+	9	2 x 9 = 18
Course 8	2	A+	9	2 x 9 = 18
	24			**199**

Thus**, SGPA = 199 ÷ 24 = 8.29**

b. Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (160) for B. Tech degree in Engineering & Technology is calculated taking into account all the courses undergone by a student over all the semesters of a program, i. e : **CGPA = ∑(Ci x Si) / ∑Ci**

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

Illustration:

CGPA after Final Semester

Semester (ith)	**No. of Credits (Ci)**	**SGPA (Si)**	**Credits x SGPA (Ci X Si)**
1	19	6.83	19 x 6.83 = 129.77
2	21	7.29	21 x 7.29 = 153.09
3	22	8.11	22 x 8.11 = 178.42
4	22	7.40	22 x 7.40 = 162.80
5	22	8.29	22 x 8.29 = 182.38
6	22	8.58	22 x 8.58 = 188.76
7	22	9.12	22 x 9.12 = 200.64
8	10	9.25	10 x 9.25 =92.50
Cumulative	**160**		**1288.36**

Thus, **CGPA** = 19x6.83+21x7.29+22x8.11+22x7.40+22x8.29+22x8.58+22x9.12+10x9.25 = 8.05

160

c. Conversion of grades into percentage:

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration: CGPA Earned 8.05 x 10=80.5

d. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

13. Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows.

CGPA	Grade (Numerical Index)	Letter Grade	Performance	FGP
	G			Qualitative Index
9 >= CGPA 10	10	O	Outstanding	Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
> 5 CGPA < 5.5	5.5	C+	Average	
> 4 CGPA <5	5	C	Satisfactory	Pass
< 4 CGPA	0	F	Unsatisfactory	Unsuccessful

Overall percentage=10*CGPA

a. Provisional Grade Card: The tentative / provisional grade card will be issued by the Controller of Examinations at the end of every semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average (SGPA).**

b. Final Grade Card: Upon successful completion of B Tech Degree a Final Grade card consisting of grades of all courses successfully completed by the candidate will be issued by the Controller of Examinations.

14. Attendance Requirement:

14.1 All students must attend every lecture, tutorial and practical classes.

14.2 In case a student is on approved leave of absence (e g:- representing the University in sports, games or athletics, placement activities, NCC, NSS activities and such others) and / or any other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

14.3 Any student with less than 75% of attendance in aggregate of all the courses including practical courses / field visits etc, during a semester shall not be permitted to appear to the end semester examination and such student shall seek re-admission

15. Re-Registration and Re-Admission:

15.1 In case a candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for semester end examination and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

15.2 In such case where in a candidate drops all the courses in a semester due to personal reasons, it is considered that the candidate has dropped the semester and he / she shall seek re-admission to such dropped semester.

16. Absence during Internal Test:

In case a student has been absent from an internal tests due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the School, for conducting a separate internal test. The Director of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special internal test for such candidate(s) well in advance before the Semester End Examination of that respective semester. Under no circumstances internal tests shall be held / assignments are accepted after Semester End Examination.

17. Provision for Appeal

If a candidate is not satisfied with the evaluation of Internal Assessment components (Internal Tests and Assignments), he/she can approach the Grievance Cell with the written submission together with all facts, the assignments, and test papers, which were evaluated. He/she can do so before the commencement of respective semester-end examination. The Grievance Cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the University on the candidate if his/her submission is found to be baseless and unduly motivated. This Cell may recommend for taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the Grievance committee is final.

18. Grievance Committee:

In case of students having any grievances regarding the conduct of examination, evaluation and announcement of results, such students can approach Grievance Committee for redressal of grievances.

For every program there will be one grievance committee. The composition of the grievance committee is as follows:-

- The Controller of Examinations - Ex-officio Chairman / Convener
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.
- One Senior Faculty Members / Subject Experts drawn from outside the University school / department – Member.

19. Eligibility to Appear for Semester End Examination (SEE)

Only those students who fulfil a minimum of 75% attendance in aggregate of all the courses including practical courses / field visits etc., as part of the program shall be eligible to appear for Semester End Examination

20. Provision for Supplementary Examination

In case a candidate fails to secure a minimum of 25% (13 marks) in Semester End Examination (SEE) and a minimum of 40% marks together with IA and SEE to declare pass in the course, such candidate shall seek supplementary examination of only such course(s) wherein his / her performance is declared unsuccessful. The supplementary examinations are conducted after the announcement of even semester examination results. The candidate who is unsuccessful in a given course(s) shall appear for supplementary examination of odd and even semester course(s) to seek for improvement of the performance.

21. Provision to Carry Forward the Failed Subjects / Courses:

The student who has failed in a maximum of 4 courses in odd and even semesters together shall move to next semester of succeeding year(s) of study till 8th semester. And he / she shall appear for Semester End

examination of failed courses of previous semesters concurrently with odd semester end examinations and / or even semester end examinations of current year of study.

Case 1: A student who has failed in a maximum of 4 courses in 1st and 2nd semester together shall move to the 3rd semester of the succeeding year.

Case 2: A student who has failed in a maximum of 4 courses from semester 1 to 4 together shall move to the 5th semester of the succeeding year.

Case 3: A students who has failed in a maximum of 4 courses from semester 1 to 6 together shall move to the 7th semester of the succeeding year.

22. Challenge Valuation:

a. A student who desires to apply for challenge valuation shall obtain a photo copy of the answer script(s) of semester end examination by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the grade awarded to him/her by surrendering the grade card and by submitting an application along with the prescribed fee to the Controller of Examinations within 10 days after the announcement of the results. This challenge valuation is only for semester end examination.

b. The answer scripts (in whatever form) for which challenge valuation is sought for shall be evaluated by the external examiner who has not involved in the first evaluation. The higher of two marks from first valuation and challenge valuation shall be the final.

23. With regard to any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

24. All assessments must be done by the respective Schools as per the guidelines issued by the Controller of Examinations. However, the responsibility of announcing final examination results and issuing official transcripts to the students lies with the office of the Controller of Examinations.

SCHOOL OF MECHANICAL ENGINEERING

Curriculum Structure for B. Tech Mechanical Engineering Program

SEMESTER-1 (Cycle-1)

Sl. No	Course Code	Title of the Course	HC/FC/SC/ OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours / Week
					L	T	P	Total	
1	B20AS0103	Differential Equations and Linear Algebra	FC	PUC/ Equivalent	3	0	0	3	3
2	B20AS0107	Physics for Engineers	FC	PUC/ Equivalent	3	0	1	4	5
3	B20CS0101	Introduction to Data Science	HC	PUC/ Equivalent	2	0	1	3	4
4	B20ER0101	Introduction to Engineering Mechanics	HC	PUC/ Equivalent	3	0	0	3	3
	Practical /Term Work / Practice Sessions/Online /MOOC								
5	B20ME0104	Entrepreneurship	HC	PUC/ Equivalent	1	0	0	1	1
6	B20EC0101	IoT and Applications	HC	PUC/ Equivalent	1	0	1	2	3
7	B20ME0101	Computer Aided Engineering Drawing	HC	PUC/ Equivalent	2	0	1	3	4
				TOTAL	**15**	**0**	**4**	**19**	**23**
					TOTAL SEMESTER CREDITS			**19**	
					TOTAL CUMULATIVE CREDITS			**19**	
					TOTAL CONTACT HOURS			**23**	

SEMESTER-2 (Cycle-2)

Sl. No	Course Code	Title of the Course	HC/FC/SC/ OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
1	B20AS0205	Vector Calculus and Partial Differential Equations	FC	B20AS0103	3	1	0	4	4
2	B20AS0201	Applied Chemistry	FC	-	3	0	0	3	3
3	B20CI0101	Introduction to Python programming	HC	-	2	0	1	3	4
4	B20EE0101	Basic Electrical and Electronics Engineering	HC	-	3	0	1	4	5
5	B20ER0201	Elements of Mechanical Engineering	HC	-	3	0	1	4	5
	Practical /Term Work / Practice Sessions/Online /MOOC								
6	B20AS0109	Biology for Engineers	FC	-	1	0	0	1	1
7	B20ME0102	Design Thinking	HC	-	1	0	1	2	3
				TOTAL	**16**	**0**	**5**	**21**	**25**
					TOTAL SEMESTER CREDITS			**21**	
					TOTAL CUMULATIVE CREDITS			**40**	
					TOTAL CONTACT HOURS			**25**	

SEMESTER-3 (Cycle-1)

Sl. No	Course Code	Title of the Course	HC/FC/ SC/OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
1	B20AS0304	Laplace Transforms and Fourier Series	FC	B20AS0205	3	0	0	3	3
2	B20ER0301	Engineering Thermodynamics	HC		3	1	0	4	4
3	B20ER0302	Material Science	HC		3	0	0	3	3
4	B20ER0303	Manufacturing Science	HC		3	0	1	4	5
5	B20ER0304	Mechanics of Materials	HC		3	0	1	4	5
Practical /Term Work / Practice Sessions/Online /MOOC									
6	B20AH0301	Communication Skill	FC		2	0	0	2	2
7	B20LS0301	Indian constitution and Professional Ethics	FC		2	0	0	2	2
8	B20AHM301	Advanced Kannada	MC		0	0	0	0	2
	B20AHM302	Basics of Kannada	MC		0	0	0	0	2
TOTAL					**19**	**1**	**2**	**22**	**28**
TOTAL SEMESTER CREDITS								**22**	
TOTAL CUMULATIVE CREDITS								**62**	
TOTAL CONTACT HOURS								**26**	

SEMESTER-4 (Cycle-2)

Sl. No	Course Code	Title of the Course	HC/FC/SC/ OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
1	B20AS0403	Probability and Sampling Theory	FC	B20AS0304	3	0	0	3	3
2	B20ER0401	Mechanical Measurements and Metrology	HC		2	0	1	3	4
3	B20ER0402	Machining Process	HC		3	0	1	4	5
4	B20ER0403	Kinematics and Dynamics of Machines	HC		3	0	1	4	5
Practical /Term Work / Practice Sessions/Online /MOOC									
5	B20ER0404	Computer Aided Machine Drawing	HC	B20ME0101	1	0	2	3	5
6	B20ER0405	MATLAB for Mechanical Engineers	HC		0	0	1	1	2
7	B20MG0301	Management Science	HC		2	0	0	2	2
8	B20AS0303	Environmental Science	FC		2	0	0	2	2
9	B20AHM401	Universal Human Values	MC		0	0	0	0	2
TOTAL					**16**	**0**	**6**	**22**	**30**
TOTAL SEMESTER CREDITS								**22**	
TOTAL CUMULATIVE CREDITS								**84**	
TOTAL CONTACT HOURS								**30**	

SEMESTER-5

Sl. No	Course Code	Title of the Course	HC/FC/SC/ OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
1	B20ER0501	Design of Machine Elements	HC		3	1	0	4	5
2	B20ER0502	Fluid Mechanics and Machines	HC		2	1	0	3	4
3	B20ER0503	Thermal Engineering Systems	HC		4	0	0	4	4
Professional Elective-1									
4	B20ERS511	Smart Materials	SC	B20ER0302	3	0	0	3	3
	B20ERS512	Experimental Stress Analysis	SC		3	0	0	3	3
	B20ERS513	Energy Technology	SC		3	0	0	3	3
	B20ERS514	Automotive Engineering	SC		3	0	0	3	3
	B20ERS515	Statistical Quality Control	SC		3	0	0	3	3
Open Elective-1 for other school students									
5	B20MEO501	Smart Materials	OE		3	0	0	3	3
Practical /Term Work / Practice Sessions/Online /MOOC									
6	B20ER0504	Flow Analysis Using Ansys Fluent	HC		1	0	1	2	3
7	B20ER0505	Fluid Machines Lab	HC		0	0	1	1	2
8	B20ER0506	Heat Engine Lab	HC		0	0	1	1	2
9	B20PA0501	Indian Tradition and Culture	FC		1	0	0	1	1
				TOTAL	**17**	**2**	**3**	**22**	**27**
				TOTAL SEMESTER CREDITS				**22**	
				TOTAL CUMULATIVE CREDITS				**106**	
				TOTAL CONTACT HOURS				**27**	

SEMESTER-6

Sl. No	Course Code	Title of the Course	HC/FCSC/OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
1	B20ER0601	Heat Transfer	HC	B20ER0301	2	1	0	3	4
2	B20ER0602	Finite Element Methods	HC	B20ER0304	2	1	0	3	4
3	B20ER0603	Design of Transmission Elements	HC	B20ER0501	3	0	0	3	3
Professional Elective-2									
4	B20ERS611	Product Design by Additive Manufacturing	SC		3	0	0	3	3
	B20ERS612	Design for Manufacturing and Assembly	SC		3	0	0	3	3
	B20ERS613	Turbomachines	SC	B20ER0502	3	0	0	3	3
	B20ERS614	Electric and Hybrid Vehicles	SC		3	0	0	3	3
	B20ERS615	Production and Operations Management	SC	B20ERS515	3	0	0	3	3
Professional Elective-3									
5	B20ERS621	Automation in Manufacturing	SC		3	0	0	3	3
	B20ERS622	Robotic Systems Kinematics	SC		3	0	0	3	3
	B20ERS623	Refrigeration and Air Conditioning	SC		3	0	0	3	3
	B20ERS624	Aircraft Fundamentals	SC		3	0	0	3	3
	B20ERS625	Industrial Engineering	SC		3	0	0	3	3
Open Elective-2 for other school students									
6	B20MEO601	Energy Technology	OE		3	0	0	3	3
Practical /Term Work / Practice Sessions/Online /MOOC									
7	B20ER0604	Heat Transfer Lab	HC		0	0	1	1	2
8	B20ER0605	Computer Aided Engineering Analysis Lab	HC		0	0	1	1	2
9	B20ER0606	Technical Documentation	FC		1	0	0	1	1
10	B20ER0607	Research Based Mini Project	HC		0	0	1	1	3
				TOTAL	**17**	**2**	**3**	**22**	**28**
								TOTAL SEMESTER CREDITS	**22**
								TOTAL CUMULATIVE CREDITS	**128**
								TOTAL CONTACT HOURS	**28**

SEMESTER-7

Sl. No	Course Code	Title of the Course	HC/FC/ SC/ OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
1	B20ER0701	Vibrations and Noise Engineering	HC		2	1	0	3	4
2	B20ER0702	CAD/CAM/CIM	HC		2	1	0	3	5
3	B20ER0703	Mechatronics and Control Systems	HC		3	0	0	3	3
4	B20ER0704	Engineering Economics and Financial Management	HC		3	0	0	3	3
Professional Elective-4									
5	B20ERS711	IoT and Machine Learning in Manufacturing	SC		3	0	0	3	3
	B20ERS712	Robotic Systems Dynamics and Control	SC	B20ERS622	3	0	0	3	3
	B20ERS713	Computational Fluid Dynamics	SC		3	0	0	3	3
	B20ERS714	Micro Electro Mechanical Systems	SC		3	0	0	3	3
	B20ERS715	Total Quality Management and Six Sigma	SC	B20ERS615	3	0	0	3	3
	B20ERS716	Internship Phase-1	SC		0	0	3	3	3
Professional Elective-5									
6	B20ERS721	Fluid Power Engineering	SC		3	0	0	3	3
	B20ERS722	Tribology	SC		3	0	0	3	3
	B20ERS723	Solar Energy Systems	SC		3	0	0	3	3
	B20ERS724	Autonomous Vehicles	SC		3	0	0	3	3
	B20ERS725	Operation Research	SC		3	0	0	3	3
	B20ERS726	Internship	SC		0	0	3	3	3
Open Elective-3 for other school students									
7	B20MEO701	Electric and Hybrid Vehicles	OE		3	0	0	3	3
Practical /Term Work / Practice Sessions/Online /MOOC									
8	B20ER0705	Design Lab	HC		0	0	1	1	2
9	B20ER0706	CIM and Machine Learning Lab	HC		0	0	1	1	2
				TOTAL	**20**	**1**	**2**	**23**	**26**
								TOTAL SEMESTER CREDITS	**23**
								TOTAL CUMULATIVE CREDITS	**151**
								TOTAL CONTACT HOURS	**26**

SEMESTER-8

Sl. No	Course Code	Title of the Course	HC/FC/SC / OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
Open Elective-4 for other school students									
1	B20MEO801	Total Quality Management and Six Sigma	OE		3	0	0	3	3
Practical /Term Work / Practice Sessions/Online /MOOC									
2	B20ER0801	Major Project	HC		0	0	6	6	18
				TOTAL	**3**	**0**	**6**	**9**	**21**
					TOTAL SEMESTER CREDITS			**9**	
					TOTAL CUMULATIVE CREDITS			**160**	
					TOTAL CONTACT HOURS			**21**	

List of Professional Electives

Sl. No	Course Code	Title of the Course
1	B20ERS511	Smart Materials
2	B20ERS512	Experimental Stress Analysis
3	B20ERS513	Energy Technology
4	B20ERS514	Automotive Engineering
5	B20ERS515	Statistical Quality Control
6	B20ERS611	Product Design by Additive Manufacturing
7	B20ERS612	Design for Manufacturing and Assembly.
8	B20ERS613	Turbomachines
9	B20ERS614	Electric and Hybrid Vehicles
10	B20ERS615	Production and Operations Management
11	B20ERS621	Automation in Manufacturing
12	B20ERS622	Robotic Systems Kinematics
13	B20ERS623	Refrigeration and Air Conditioning
14	B20ERS624	Aircraft Fundamentals
15	B20ERS625	Industrial Engineering
16	B20ERS711	IoT and Machine Learning in Manufacturing
17	B20ERS712	Robotic Systems Dynamics and Control
18	B20ERS713	Computational Fluid Dynamics
19	B20ERS714	Micro Electro Mechanical Systems
20	B20ERS715	Total Quality Management and Six Sigma
21	B20ERS716	Internship Phase-1
22	B20ERS721	Fluid Power Engineering
23	B20ERS722	Tribology
24	B20ERS723	Solar Energy Systems
25	B20ERS724	Autonomous Vehicles
26	B20ERS725	Operation Research
27	B20ERS726	Internship

List of Open Elective Courses

Sl. No	Course Code	Semester	Open Elective Course Name	Offered by	Offered to School
1	B20CEO501	5	BUILDING MATERIALS AND CONSTRUCTION	CE	All Engineering
2	B20CEO601	6	BUILDING PLANNING AND BYE LAWS	CE	All Engineering
3	B20CEO701	7	DISASTER PREPAREDNESS, PLANNING AND MANAGEMENT	CE	All Engineering
4	B20CEO801	8	ROAD SAFETY AND MANAGEMENT	CE	All Engineering
5	B20CIO501	5	INTRODUCTION TO AI	CI	Mech, Civil, ECE,EEE
6	B20CIO502	5	OOPS WITH C++	CI	Mech, Civil, ECE,EEE
7	B20CIO503	5	WEB TECHNOLOGY	CI	Mech, Civil, ECE,EEE
8	B20CIO601	6	DATA MINING	CI	Mech, Civil, ECE,EEE
9	B20CIO602	6	MACHINE LEARNING	CI	Mech, Civil, ECE,EEE
10	B20CIO603	6	NEURAL NETWORKS	CI	Mech, Civil, ECE,EEE
11	B20CIO701	7	DEEP LEARNING	CI	Mech, Civil, ECE,EEE
12	B20CIO702	7	PYTHON FOR DATA SCIENCE	CI	Mech, Civil, ECE,EEE
13	B20CIO801	8	IOT PROGRAMMING	CI	Mech, Civil, ECE,EEE
14	B20CIO802	8	REINFORCEMENT LEARNING	CI	Mech, Civil, ECE,EEE
15	B20CSO501	5	DATABASE MANAGEMENT SYSTEMS	CS	All Engineering
16	B20CSO601	6	DATA STRUCTURES	CS	All Engineering
17	B20CSO701	7	JAVA PROGRAMMING	CS	All Engineering
18	B20CSO801	8	R PROGRAMMING LANGUAGE	CS	All Engineering
19	B20ECO501	5	SENSORS AND INSTRUMENTATION	EC	All Engineering
20	B20ECO601	6	MICROPROCESSORS AND MICROCONTROLLERS	EC	All Engineering
21	B20ECO801	7	AUTOMOTIVE ELECTRONICS	EC	All Engineering
22	B20ECO802	8	ROBOTICS AND AUTOMATION	EC	All Engineering
23	B20EEO501	5	ENERGY CONSERVATION	EE	All Engineering
24	B20EEO601	6	ELECTRICAL SAFETY AND REGULATIONS	EE	All Engineering
25	B20EEO801	7	RENEWABLE ENERGY SYSTEM	EE	All Engineering
26	B20EEO802	8	TROUBLE SHOOTING OF COMMON ELECTRICAL APPLIANCES	EE	All Engineering
27	B20MDO501	5	BIOPYTHON	MD	All Engineering
28	B20MDO601	6	BIOSENSORS AND BIOELECTRONICS	MD	All Engineering
29	B20MDO701	7	COGNITIVE NEUROSCIENCE	MD	All Engineering
30	B20MDO801	8	CYBER SECURITY AND FORENSICS	MD	All Engineering
31	B20MEO501	5	SMART MATERIALS	ME	All Engineering
32	B20MEO601	6	ENERGY TECHNOLOGY	ME	All Engineering
33	B20MEO701	7	ELECTRIC AND HYBRID VEHICLES	ME	All Engineering
34	B20MEO801	8	TOTAL QUALITY MANAGEMENT AND SIX SIGMA	ME	All Engineering

Detailed Syllabus

1st Semester

Course Title	Differential Equations and Linear Algebra				Course Type		FC	
Course Code	B20AS0103	Credits	3		Class		I semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50%**	**50%**

COURSE OVERVIEW

This course is introduction to applied mathematics, which is useful for Mechanical engineering students. This course covers identifying and methods of solving differential equation of first and higher order along with applications to engineering problems. Most importantly learn linear algebra topics like linear transformation, solving linear system of equations and determining Eigen values and Eigen vectors.

COURSE OBJECTIVES

1. To impart the Knowledge of first order ordinary differential equations and its applications in the field of engineering.
2. To impart the Knowledge of higher order linear differential equations and its applications in the field of engineering.
3. To study different methods to solve consistent system of algebraic equations.
4. To study Eigen values and Eigen vectors using numerical method, diagonalization and canonical forms.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Recognize and solve first-order ordinary differential equations.	1, 2	1
CO2	Analyze and solve differential equations of electrical circuits, forced oscillation of mass spring and elementary heat transfer.	1, 2	1
CO3	Summarize matrices techniques for solving systems of linear equations in the different areas of Linear Algebra.	1, 2, 5	1
CO4	Executing the techniques to determine largest Eigen value and corresponding Eigen vector.	1, 2, 5	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓	✓	✓		✓	
CO2		✓	✓		✓	
CO3	✓	✓	✓		✓	
CO4		✓	✓		✓	

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2												2	
CO2	3	2												2	

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO3	3	2			1									2	
C04	3	2			1									2	
Average	3	2			1									2	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit – 1

Differential equations of First order and first degree: (Recap: Variable separable, Homogenous and Linear equations) Bernoulli's equation, Exact Differential Equations, Equation reducible to exact [IF for the case of $\frac{1}{M}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ ***and*** $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ ***only***].Orthogonal trajectories (both Cartesian and polar form), Engineering applications.

Unit – 2

Linear differential equations: Linear differential equations with constant coefficients: inverse differential operator method and method of variation of parameters. Linear differential equations with variable coefficients: Solution of Cauchy's and Legendre's linear differential equations, engineering applications.

Unit – 3

Linear Algebra: Rank of Matrix by elementary transformations, Linear System of Equations, Conditions of Existence and Uniqueness of Solutions. Solution of linear system of equations by Gauss Elimination, Gauss – Jordan and Gauss-Seidel method, Engineering applications.

Unit – 4

Matrix theory: Eigen Values and Eigen Vectors, Rayleigh's power method to find the largest Eigen value and the corresponding Eigen vector. Linear transformation, diagonalization of a square matrix. Reduction of Quadratic form to Canonical form, engineering applications.

TEXT BOOKS

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th Reprint edition, 2013
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43nd edition, 2015

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th Edition, 2013.
2. P.V. O'Neil, "Advanced Engineering Mathematics", Thomson Mathematical Methods by Potter & Goldberg; Publisher: PHI.

JOURNALS / MAGAZINES:

1. https://www.journals.elsevier.com/journal-of-differential-equations
2. https://www.journals.elsevier.com/linear-algebra-and-its-applications

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/111/106/111106051/
2. https://nptel.ac.in/courses/111/104/111104031/
3. https://www.coursera.org/learn/differential-equations-engineers

Course Title	Physics for Engineers				Course Type		FC	
Course Code	B20AS0107	Credits	4		Class		I semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**4**	**5**	**5**	**40**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Fundamental Physics is very important and necessary basic subject for all branches of engineering students. It provides the fundamental knowledge of basic principles of Physics which is required for basic foundation in engineering education irrespective of branch. This course introduces the basic concepts of Physics and its applications to Mechanical Engineering courses by emphasizing the concepts underlying four units .1 Lasers and optical fibers , 2.Quantum effects like blackbody radiations ,photoelectric effect , electromagnetic radiations 3.Quantum mechanics and its applications ,4.Theories of solids to explain electrical properties of materials(Conductors, semiconductors, insulators and superconductors) etc.. This subject has basic laws expressions and theories which helps to increase the scientific knowledge to analyze upcoming technologies. The course also consists of real time and numerical examples which makes subject interesting and attractive.

COURSE OBJECTIVES

This course enables graduating students

1. To understand the basic concepts and principles of Physics to analyze practical engineering problems and apply its solutions effectively and efficiently.
2 To gain the knowledge of different physical phenomena, quantum/wave mechanics and materials science.
3. To understand design issues, practical oriented skills and problem solving challenges.

COURSEOUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Explain CO_2 and semiconductor laser working and applications. Classify optical fibers and derive expression for NA, number of Modes and attenuation.	1, 9, 10	2,3
CO2	Analyze quantum effects like blackbody radiations , photoelectric effect , electromagnetic radiations	1, 2, 9, 10	2, 3
CO3	Interpret laws of quantum mechanics and its applications	1, 2	2, 3
C04	Compare theories of solids to explain electrical behavior of materials (Conductors, semiconductors, insulators and superconductors) etc.	1, 2, 9,10	2, 3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓	✓	✓	✓		
CO2	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		
C04	✓	✓	✓	✓		

COURSE ARTICULATIONMATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3								2	1	1	1	3	3	1
CO2	3	2							1	1	1	1	3	3	1
CO3	3	2								1	1	1	3	3	1
C04	3	2							1	1	1	1	3	3	1
Average	3	2							1.3	1	1	1	3	3	1

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Lasers: Lasers Interaction between radiation and matter, Expression for energy density at thermal equilibrium in terms of Einstein's coefficients. Characteristics of laser light, Conditions for laser operation, Requisites of laser system, Construction and working of Carbon Dioxide (CO_2) laser, semiconductor laser and Applications of laser. Optical fibers: Construction and light propagation mechanism in optical fibers, Acceptance angle, Numerical Aperture (NA), Expression for numerical aperture in terms of core and cladding refractive indices, Types of optical fibers, Attenuation and reasons for attenuation, optical fiber communication using block diagram, Advantages and limitations. Working of LED and Photodiode.

Unit-2

Electromagnetic Waves: Wave equation in differential form in free space. Plane electromagnetic waves in vacuum, their transverse nature. Polarization of electromagnetic waves (qualitatively)

Quantum Physics: Black body radiation spectrum, Stefan's law of radiation, Plank's quantum theory of radiation, verification of Weins law and Rayleigh Jeans law, using planks law. Wave Particle dualism, deBroglie hypothesis, Matter waves, Photoelectric effect, Compton Effect (qualitative).

Unit-3

Quantum Mechanics: Heisenberg's uncertainty principle, and its applications (nonexistence of electron inside the nucleus). Wave function, properties of wave function and physical significance. Probability density and Normalization of wave function, Schrodinger time independent wave equation, Eigen values and Eigen functions. Applications of Schrödinger wave equation – Particle in one dimensional infinite potential well with numerical examples.

Unit-4

Electron Theory of Metals: Classical free electron theory and its failures. Quantum Free electron theory and its success, density of states, Fermi-Dirac statistics (qualitative), Fermi factor, Fermi level, Fermi energy.

Physics of Semiconductor: Band structure – types of semiconductors-mention the expression for concentration of electrons and Holes in intrinsic semiconductors, Expression for electrical Conductivity of semiconductors in terms of energy gap and temperature. (Derivation)

Dielectric materials: polar and non-polar dielectrics, types of polarizations. Internal fields in a one dimensional solid dielectric (Derivation), Applications and Numerical problems.

Superconductivity and properties of superconductors.

PRACTICE:

Sl. No.	Title of the Experiment
1.	Variation of Resistivity of intrinsic Semi-conductor crystal using four probe method
2.	Determination Value of Planck's constant by using light emitting diode
3.	Attenuation and propagation characteristics of optical fiber cable.
4.	Determination of numerical aperture of a given optical fiber.
5.	To find the laser parameters–wavelength and divergence of laser light by diffraction method.
6.	Photo Diode Characteristics (Study of I–V characteristics in reverse bias and variation of photocurrent as a function of reverse voltage and intensity
7.	Dielectric constant of a capacitor by charging and discharging of a capacitor
8.	Determination of particle size using laser.
9.	Band gap of intrinsic Semi-conductor
10.	Verification of Stefan's law of radiation by electrical method

TEXT BOOKS

1. M.N. Avadhanulu and P.G. Kshirsagar , "A Text book of Engineering Physics", S. Chand & Company Ltd, New Delhi, 10th revised Ed,.
2. Gaur and Gupta, "Engineering Physics", Dhanpat Rai Publications, 2017.

REFERENCE BOOKS

1. Arthur Beiser, "Concepts of Modern Physics", Tata McGraw Hill Edu Pvt Ltd- New Delhi, 6th Edition, 2006
2. M K Verma, "Introduction to Mechanics", University Press (India) Pvt Ltd, Hyderabad, 2nd Edition, 2009.
3. B B laud, "Lasers and Non Linear Optics", New Age International Publishers, 3rd Edition, 2011
4. S O Pillai, "Solid State Physics", New Age International Publishers, 8th Edition, 2018.

Course Title	**Introduction to Data Science**				**Course Type**		**Hard Core**	
Course Code	**B20CS0101**	**Credits**	**3**		**Class**		**I Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**4**	**4**	**26**	**26**	**50 %**	**50 %**

COURSE OVERVIEW:

Data Science is an interdisciplinary, problem-solving oriented subject that is used to apply scientific techniques to practical problems. The course orients on preparation of datasets and programming of data analysis tasks. This course covers the topics: Set Theory, Probability theory, Tools for data science, ML algorithms and demonstration of experiments by using MS-Excel.

COURSE OBJECTIVES

The objectives of this course are to:

1. Explain the fundamental concepts of Excel.
2. Illustrate the use of basic concepts of Data Science in the real world applications.
3. Demonstrate the use of SQL commands in real world applications.
4. Discuss the functional components of Data Science for real world applications

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Make use of the concepts of Data Science in developing the real world applications.	1, 2, 3, 4, 5	1,2,3

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO2	Apply the SQL commands in developing the real-world applications.	1, 2, 3, 4, 5	1,2,3
CO3	Build the data analytics solutions for real world problems, perform analysis, interpretation and reporting of data.	1, 2, 3, 4, 5	1, 2, 3
CO4	Create the real world AI based solutions using different machine learning algorithms	1, 2, 3, 4, 5	1, 2, 3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember(L1)	Understand(L2)	Apply(L3)	Analyze(L4)	Evaluate(L5)	Create(L6)
CO1			✓			
CO2			✓			
CO3			✓	✓		
CO4			✓	✓	✓	✓

COURSE ARTICULATION MATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2								3	3	3
CO2	2	2	2	2	2								3	3	3
CO3	3	3	2	2	2								3	3	3
C04	3	3	3	2	2								3	3	3
Average	2.8	2.8	2.3	2	2								3	3	3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

Unit -1

Introduction to Microsoft Excel: Creating Excel tables, understand how to Add, Subtract, Multiply, Divide in Excel. Excel Data Validation, Filters, Grouping. Introduction to formulas and functions in Excel. Logical functions (operators) and conditions. Visualizing data using charts in Excel. Import XML Data into Excel How to Import CSV Data (Text) into Excel, How to Import MS Access Data into Excel, Working with Multiple Worksheets.

Unit -2

Introduction to Data Science: What is Data Science? Probability theory, bayes theorem, bayes probability; Cartesian plane, equations of lines, graphs; exponents.

Introduction to SQL: SQL: Creation, insertion, deletion, retrieval of Tables by experimental demonstrations. Import SQL Database Data into Excel

Unit -3

Data science Components: Tools for data science, definition of AI, types of machine learning (ML), list of ML algorithms for classification, clustering, and feature selection. Description of linear regression and Logistic Regression. Introducing the Gaussian, Introduction to Standardization, Standard Normal Probability Distribution in Excel, Calculating Probabilities from Z-scores, Central Limit Theorem, Algebra with Gaussians, Markowitz Portfolio Optimization, Standardizing x and y Coordinates for Linear Regression, Standardization Simplifies Linear Regression, Modeling Error in Linear Regression, Information Gain from Linear Regression.

Unit- 4

Data visualization using scatter plots, charts, graphs, histograms and maps: Statistical Analysis: Descriptive statistics- Mean, Standard Deviation for Continuous Data, Frequency, and Percentage for Categorical Data.

Applications of Data Science: Data science life cycle, Applications of data science with demonstration of experiments either by using Microsoft Excel.

PRACTICE:

<table>
<tr><th>Sl.No</th><th>Title of the Experiment</th><th>Tools and Techniques</th><th>Expected Skill/Ability</th></tr>
<tr><td>1.</td><td>The height (in cm) of a group of fathers and sons are given below, Find the lines of regression and estimate the height of son when the height of father is 164 cm.
<table>
<tr><td>Plot the graph. Hgt of Fathers</td><td>158</td><td>166</td><td>163</td><td>165</td><td>167</td><td>170</td><td>167</td><td>172</td><td>177</td><td>181</td></tr>
<tr><td>Hgt of Sons</td><td>163</td><td>158</td><td>167</td><td>170</td><td>160</td><td>180</td><td>170</td><td>175</td><td>172</td><td>175</td></tr>
</table></td><td>MS Excel</td><td>Create and perform operations on Excel data set by applying Linear regression</td></tr>
<tr><td>2.</td><td>Using the data file DISPOSABLE INCOME AND VEHICLE SALES, perform the following:
i) Plot a scatter diagram.
ii) Determine the regression equation.
iii) Plot the regression line (hint: use MS Excel’s Add Trend line feature).
iv) Compute the predicted vehicle sales for disposable income of $16,500 and of $17,900.
v) Compute the coefficient of determination and the coefficient of correlation</td><td>MS Excel</td><td>Perform prediction and visualization of data</td></tr>
<tr><td>3.</td><td>Managers model costs in order to make predictions. The cost data in the data file INDIRECT COSTS AND MACHINE HOURS show the indirect manufacturing costs of an ice-skate manufacturer. Indirect manufacturing costs include maintenance costs and setup costs. Indirect manufacturing costs depend on the number of hours the machines are used, called machine hours. Based on the data for January to December, perform the following operations.

i) Plot a scatter diagram.
ii) Determine the regression equation (hint: use MS Excel’s Add Trend line feature).
iii) Compute the predicted indirect manufacturing costs for 300 machine hours and for 430 machine hours.</td><td>MS Excel</td><td>Perform prediction and visualization of data</td></tr>
</table>

<table>
<tr>
<td>4.</td>
<td>Apply multiple linear regression to predict the stock index price which is a dependent variable of a fictitious economy based on two independent / input variables interest rate and unemployment rate.
<table>
<tr><th>Year</th><th>month</th><th>interest rate</th><th>unemployment rate</th><th>stock index price</th></tr>
<tr><td>2020</td><td>10</td><td>2.75</td><td>5.3</td><td>1464</td></tr>
</table>
</td>
<td>MS Excel</td>
<td>Perform prediction and visualization of data</td>
</tr>
<tr>
<td>5.</td>
<td>Calculate the total interest paid on a car loan which has been availed from HDFC bank. For example, Rs.10, 00,000 has been borrowed from a bank with annual interest rate of 5.2% and the customer needs to pay every month as shown in table below. Calculate the total interest rate paid for a loan availed of Rs.10, 00,000 during 3 years.
<table>
<tr><th>Sl No.</th><th>A</th><th>B</th></tr>
<tr><td>1</td><td>Principal</td><td>Rs.10,00,000</td></tr>
<tr><td>2</td><td>Annual interest rate</td><td>5.20%</td></tr>
<tr><td>3</td><td>Year of the loan</td><td>3</td></tr>
<tr><td>4</td><td>Starting payment number</td><td>1</td></tr>
<tr><td>5</td><td>Ending payment number</td><td>36</td></tr>
<tr><td>6</td><td>Total interest paid during period</td><td>?</td></tr>
</table>
</td>
<td>MS Excel</td>
<td>Create Excel data and perform EMI estimator</td>
</tr>
<tr>
<td>6.</td>
<td>Create a supplier database of 10 records with SUPPLIER_ID as primary key, SUPPLIER_NAME, PRODUCTS, QUANTITY, ADDRESS, CITY, PHONE_NO and PINCODE, Where SUPPLIER_NAME, PRODUCTS, QUANTITY and PHONE_NO, should not be NULL.</td>
<td>SQL</td>
<td>Creating Tables</td>
</tr>
<tr>
<td>7.</td>
<td>Create the customer database of a big Market with CUSTOMER_ID as primary key, CUSTOMER_NAME, PHONE_NO, EMAIL_ID, ADDRESS, CITY and PIN_CODE. Store at least twenty customer’s details where CUSTOMER_NAME and PHONE_NO are mandatory and display the customer data in alphabetical order.</td>
<td>SQL</td>
<td>Creating and retrieving Tables</td>
</tr>
<tr>
<td>8.</td>
<td>Apply linear regression to find the weather (temperature) of a city with the amount of rain in centimeters. Create your own database with following details.
<table>
<tr><th>CITY</th><th>Temperature in Centigrade</th><th>Rain in Centimeters</th></tr>
<tr><td></td><td></td><td></td></tr>
</table>
</td>
<td>MS Excel</td>
<td>Apply Linear regression</td>
</tr>
<tr>
<td>9.</td>
<td>Use the linear regression technique to compare the age of humans with the amount of sleep in hours.
<table>
<tr><th>Name</th><th>Age in Years</th><th>Sleep in hours</th></tr>
</table>
Create your own database with above details.
</td>
<td>MS Excel</td>
<td>Apply Linear regression</td>
</tr>
</table>

10.	Apply the linear regression, compare the average salaries of batsman depending on the run rate scored/ recorded in the matches. Assume your own database.	MS Excel	**Apply Linear regression**
11.	Design the ER diagram and create schema of the REVA library management system.	Entity Relationship	Entity Relationship
12.	Design the ER diagram and create schema for Hospital Management system.	Entity Relationship	Schema design

TEXT BOOKS

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.
2. Ramakrishnan and Gehrke , "Database Management systems", McGraw Hill Publications, 3rd Edition 2003.
3. Mastering Data Analysis in Excel – https://www.coursera.org/learn/analytics-excel.
4. Kenneth N. Berk, Carey, "Data Analysis with Microsoft Excel", S. Chand & Company, 2004**.**

REFERENCE BOOKS

1. B.V. Ramana, "Higher Engineering Mathematics",Tata McGraw Hill Publications, 19th Edition, 2013.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th Edition, 2013.
3. Seymour Lipschutz, John J. Schiller, "Schaum's Outline of Introduction to Probability and Statistics", McGraw Hill Professional, 1998.

JOURNALS/MAGAZINES

1. https://www.journals.elsevier.com/computational-statistics-and-data-analysis
2. https://www.springer.com/journal/41060
3. International Journal on Data Science and Analytics
4. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8254253
5. IEEE Magazine on Big data and Analytics

SWAYAM/NPTEL/MOOCs

1. Excel Skills for Business: Essentials, Macquarie University (https://www.coursera.org/learn/excel-essentials)
2. SQL for Data Science, University of California, Davis (https://www.coursera.org/learn/sql-for-data-science)
3. Data Science Math Skills, Duke University (https://www.coursera.org/learn/datasciencemathskills)
4. https://www.edx.org/course/subject/data-science
5. https://onlinecourses.nptel.ac.in/noc19_cs60/preview

SELF-LEARNING EXERCISES

1. Relational database management system.
2. Advanced MS-Excel

Course Title	**Introduction to Engineering Mechanics**				**Course Type**		**Hard Core**	
Course Code	**B20ER0101**	**Credits**	**3**		**Class**		**I semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

The primary purpose of the study of Introduction to Engineering Mechanics is to develop the capacity to predict the effects of force and motion while carrying out the creative design functions of engineering. This capacity requires more than a mere knowledge of the physical and mathematical principles of mechanics; also required is the ability to visualize physical configurations in terms of real materials, actual constraints ,and the practical

limitations which govern the behavior of machines and structures. One of the primary objectives in a mechanics course is to help the student develop this ability to visualize, which is so vital to problem formulation.

COURSE OBJECTIVE

This course enables graduating students to identify, analyze, formulate, and solve engineering problems by applying principles of engineering, Mathematics and Physics.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Determine the Resultant force and moment for a given system of forces.	1	1
CO2	Analyses and apply the knowledge of centroid, and moment of inertia for composite plane figures.	1,2	1,2
CO3	Apply knowledge of support reaction to find reaction forces and equilibrium condition for different beams and also Analyses planer and spatial to determine the forces in the member of trusses.	1,2	1.2
CO4	To evaluate the friction forces required to hold a system in static equilibrium and also determine the properties of a system or its loads for which a system will be in a condition of impending motion.	1,2	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓	✓		
CO3			✓	✓		
CO4		✓	✓			

COURSE ARTICULATIONMATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											1		
CO2	3	3											1	3	
CO3	3	3											1	3	
CO4	3	1											1	3	
Average	3	2.3											1	3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Introduction: Engineering Mechanics, Idealization of bodies, Basics concepts, fundamental principles, system of units.

Concurrent forces in a plane: Concept of force, vector, Parallelogram law of forces, Moment of force, Moment of couple, simple problems on force and couple, Composition of forces by method of resolution, Numerical Problems

Unit-2

Non-Concurrent forces in a plane: Varignon's principle moments, resultants of non-concurrent force system, Numerical problems.Equilibrium of Concurrent forces in a plane Types of forces acing on the body, free body diagram, Equation of Equilibrium, Lami's theorem, equilibrium of connected bodies, Numerical problems.

Equilibrium of Non Concurrent forces in a plane: Equilibrium equation and Numerical Problems.

Unit-3

Centroid: Centre of gravity, center of gravity of a body, concept of centroid, centroid of two dimensional body, Determination of centroid or center of Gravity – integration method. Centroid of a composite plane figure.

Moment of Inertia: Moment of inertia of plane figure, polar moment of Inertia, radius of gyration, theorems of moment of Inertia, finding moment of inertia for standard sections.

Unit-4

Supporting Reaction: Types of support, Types of Beams, Types of loading, finding support reactions.

Introduction to Simples trusses: Types of Frames and its applications, Assumptions, Nature of forces in members. Numerical on pin joint stresses only

Friction: Introduction, law of friction, block resting on horizontal and inclined plane, Application of wedge and ladder, Rope and pulley systems.

TEXT BOOK

1. Ferdinand P. Beer, E. Russell Johnston, Jr. David F. Mazurek, Phillip J. Cornwell, with the collaboration of Brian P. Self, "Vector Mechanics for Engineers static and Dynamics", Tata McGraw Hill, 12th Edition.

REFERENCE BOOKS

1. Shames. I. H, and Krishna Mohana Rao.G, "Engineering Mechanics (Statics and Dynamics)", Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2006.
2. Hibbeler. R.C., "Engineering Mechanics: Statics & Dynamics", Pearson Education (US), 14th Edition, 2015.

JOURNALS/MAGAZINES

1. https://ascelibrary.org/journal/jenmdt
2. https://www.scimagojr.com/journalsearch.php?q=22062&tip=sid

SWAYAM/NPTEL/MOOCs:

1. https://swayam.gov.in/explorer?searchText=Engineering%20mechanics
2. https://nptel.ac.in/downloads/111104026/
3. https://www.coursera.org/learn/engineering-mechanic

Course Title	**Entrepreneurship**				**Course Type**		**Hard Core**	
Course Code	**B20ME0104**	**Credits**	**1**		**Class**		**I semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**1**	**1**	**13**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This introductory course is designed to introduce you to the foundational concepts of entrepreneurship, including the definition of entrepreneurship, the profile of the entrepreneur, the role of venture creation in society. The course also provides a bird's eye view on the steps to start a venture, financing, marketing as well as support by various institutions towards entrepreneurship.

COURSE OBJECTIVES

1. To understand the basic terms, concepts in Entrepreneurship Development
2. To analyze and apply for the supporting schemes towards entrepreneurship

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Understand and explain the key terms, definitions, and concepts used in Entrepreneurship Development	6-12	3
CO2	Plan a start up by applying the knowledge of sources of finance and the supporting schemes offered by state and central governments and other entrepreneurial development organizations	2, 3, 6-12	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√				
CO2	√	√	√			

COURSE ARTICULATION MATRIX

CO / Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1					1	1	1	1	1	2	1			1
CO2	1	3	1			1	1	1	1	1	3	1			2
Average	1	3	1			1	1	1	1	1	2.5	1			1.5

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Introduction to Entrepreneurship: Evolution of term 'Entrepreneurship', Factors influencing entrepreneurship', Psychological factors, Social factors, Economic factors, Environmental factors. Characteristics of an entrepreneur, Difference between Entrepreneur and Entrepreneurship, Types of entrepreneurs. New generations of entrepreneurship viz. social entrepreneurship, Edupreneurship, Health entrepreneurship, Tourism entrepreneurship, Women entrepreneurship etc., Barriers to entrepreneurship, Creativity and entrepreneurship, Innovation and inventions, Skills of an entrepreneur, Decision making and Problem Solving.

Unit-2

Institutional Support for Entrepreneurship: Organization Assistance to an entrepreneur, New Ventures, Industrial Park (Meaning, features, & examples), Special Economic Zone (Meaning, features & examples), Financial assistance by different agencies, MSME Act Small Scale Industries, Carry on Business (COB) license, Environmental Clearance, National Small Industries Corporation (NSIC), e-tender process, Excise exemptions and concession, Exemption from income tax, The Small Industries Development Bank of India(SIDBI), Incentives for entrepreneurs

TEXT BOOKS

1. K. Ramachandran, "Entrepreneurship Development", Tata Mc. Graw Hill, 2008
2. Sangeeta Sharma, "Entrepreneurship Development" PHI Publications, 2016

REFERENCE BOOKS

1. Baringer and Ireland, "Entrepreneurship", Pearson, 11th Edition, 2020.
2. P. Narayana Reddy, "Entrepreneurship – Text and Cases, Cengage Learning India", 1st Edition, 2010
3. Corporate Entrepreneurship: Building The Entrepreneurial Organization" by Paul Burns published by Palgrave Macmillan.
4. Drucker F Peter: "Innovation and Entrepreneurship", 1985.Heinemann, London.

5. Doanld F Kuratko & Richard M Hodgeth, "Entrepreneurship in the New Millennium", India Edition – South-Western, Cengage Learning

JOURNALS/MAGAZINES

1. International Small Business Journal: https://journals.sagepub.com/home/isb
2. Journal of Development Entrepreneurship: https://www.worldscientific.com/worldscinet/jde

SWAYAM/NPTEL/MOOCs:

1. Entrepreneurship: https://nptel.ac.in/courses/110/106/110106141/

Course Title	IoT and Applications				Course Type		Hard Core	
Course Code	B20EC0101	Credits	2		Class		I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	1	2	2				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Total	**2**	**3**	**3**	**13**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

The Internet of Things (IoT) expands access to the world-wide web from computers, smart phones, and other typical devices to create a vast network of appliances, toys, apparel, and other goods that are capable of connecting to the Internet. This introductory course focuses on IoT architecture, its domains and communication protocols. The course is supported with hands on sessions that incorporates different types sensors interfaced with IoT board to build IoT projects to solve real time problems. The case study of deployment of IoT in various applications are provided.

COURSE OBJECTIVES

The objectives of this course are to:

1. Explain the architecture of Internet of Things.
2. Inculcate knowledge of IoT devices, Sensors and Communication Protocols in various application domains.
3. Gain expertise in interface of various sensors to IoT Boards.
4. Discuss the various applications of IoT.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Describe the architecture of IoT eco-system	1	1,2
CO2	Identify IoT devices, architecture, sensors and Communication protocols	1	1,2
CO3	Demonstrate the interface of sensors to IoT board	1,5, 12	1,2
CO4	Realize various Applications of IoT through case studies	1,5, 12	1,2
CO5	Develop simple IoT projects and modules	1,5,9, 12	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√				
CO2		√				
CO3			√			
CO4				√	√	
CO5						√

COURSE ARTICULATION MATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	
CO2	3												3	3	
CO3	3				3							3	2	2	
CO4	3				3							3	1	1	
CO5	3				3				2			3	3	3	
Average	3				3				2			3	2.4	2.4	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

Unit – 1

IoT Basics: Introduction to IoT, How does Internet of Things Works, Features of IoT, Advantages and Disadvantages of IoT, Embedded Devices in IoT, IoT eco-system

IoT Architecture and IoT Devices: Components of IoT architecture, Stages of IoT solution architecture, Smart Objects, IoT Devices.

Unit – 2

IoT boards in Market: Arduino, Arduino UNO, ESP8266, and Raspberry Pi

IoT Platform: Amazon Web Services (AWS) IoT platform, Microsoft Azure IoT platform, Google Cloud Platform IoT, IBM Watson IoT platform, Thing Work IoT platform

Technologies Used in IoT: Bluetooth, Wi-Fi, Li-Fi, RFID, Cellular, Z-Wave.

PRACTICE:

Sl. No.	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1.	Introduction to IoT Board a. Arduino UNO b. Arduino Nano c. Node MCU d. Ethernet Shield	Hardware	• Identifications of various parts of Arduino and Node MCU boards • Study of Ethernet shield and connection to the board
2.	Working with Arduino IDE (Integrated Development Environment)	Open source Arduino IDE	• Download specified software • Modify code as per the application
3.	a) Demonstration of Multimeter usage b) Demonstration of Breadboard connection for Voltage, Ground, series and parallel connections c) Exercise to read the value of resistor using Colour code chart	Multimeter Breadboard Resistor packs	• Measurement of voltage at various points in IoT boards • Choose the value of Resistor for an application
4.	Reading photo resistor sensor value connected to Arduino Board	Arduino UNO Arduino IDE LDR , Multimeter, Resistor	• Interface of photo sensor to IoT board for light measurement applications
	Reading temperature sensor value	Arduino UNO , Arduino	• Interface of Temperature

5.	connected to Arduino Board	IDE, Temperature sensor, Multimeter	sensor to IoT board for temperature measurement application
6.	Reading motion detector sensor value connected to IoT board	Arduino UNO , Arduino IDE, pyro-dielectric sensor, Multimeter	• Interface of Motion detector sensor to IoT board for motion detection.
7	Reading distance measurement using Ultrasonic sensor Connected to IoT board	Arduino UNO, Arduino IDE, Ultrasonic sensor, Multimeter.	• Interface of Motion detector sensor to IoT board for motion detection
8	Interface relay to IoT board	Arduino UNO , Arduino IDE, relay Multimeter	Interface relay to IoT board for Switching applications
9	Connect Wifi-ESP8266 to Arduino UNO board, Send and receive data through smart phone.	Arduino UNO ESP8266, Arduino IDE Smart phone	Connect IoT board to Wifi network
Part-B (Case Study projects)			
Automated lighting system, Intelligent Traffic system, Smart Parking, Smart water management ,Smart healthcare ,IoT for smart cities, IoT and Cloud Server Based Wearable Health Sensor's Monitoring System, IoT - Industrial Internet of Things Monitoring Of Sensor's Data on Android App, Remote Patient Monitoring ,E Agriculture Monitoring on Webpage Motor Controlling with Android App. Integrated Smart Health Care Monitoring System .,Air Pollution & Water Quality Monitoring System, A Smart System connecting E-Health Sensor's and the Cloud ,Smart E-Agriculture Monitoring Using Internet Of Things, IoT based Garbage Management System ,IoT projects | Smart Home Automation using IOT ,IoT based submersible motor pumps on/off ,IoT Based Electronic Door Opener, IoT Based Garbage Monitoring ,Monitoring of Highway Hybrid Parameter & Controlling Highway Light Through Iot Based Smart Agriculture Monitoring System, IoT Based Agriculture Crop - Field Monitoring System and Irrigation Automation ,An IoT Based Patient Monitoring System using Raspberry Pi ,Underground Cable Fault Detection Over Internet Of Things (Iot) Google Map ,IoT Air & Water Quality Monitoring System, IoT Based Automatic Vehicle Accident Detection and Rescue System ,Patient Health Status Observing Based On IoT and Email Alert ,IoT Based Vehicle Accident Detection and Tracking System on google map webpage ,Data Logger System for weather monitoring using WSN ,Smart intelligent security system for women ,Building Automation System Using GRPS IoT, Implementation of Industrial Data Acquisition, management and Guiding using IoT Distance based Accident Avoidance System using CAN protocol & Tracking through IoT ,Multiple Garbage Box Monitoring & Collection system, IoT Based Garbage Monitoring System ,Swachh Bharat Waste Collection Management System using IOT			
Sl. No.	**Title of the Experiment**	**Tools and Techniques**	**Expected Skill /Ability**
PART C (Mini Project)			
1	Arduino Controlled Light intensity: design and build a simple , effective circuit called Auto Intensity Control of Street Lights using Arduino	ArduinoUNO,DS3231 RTC Module, LDR 16×2 LCD Display ,LED,10KΩ Potentiometer,10KΩ Resistor, Push Button, Connecting Wires, Breadboard	Design and Implementation of IoT project to solve Engineering Problems.
2	Thermometer: build an LCD thermometer with an Arduino	Arduino Uno, Temperature Sensor, LCD	Design and Implementation of IoT project for Engineering

	UNO and a LM35/36 analog temperature sensor.	display, Breadboard and Connecting wires	applications.
3	Motion activated light lamp: build an automated project that It switches on and off when there's motion.	Arduino Uno, PIR Motion sensor, breadboard, connecting wires, LED generic.	Design and Implementation of IoT project for Engineering applications
4	Touchless motion sensor trash can: build touchless motion sensor trash can	Arduino UNO, Ultra sonic sensor, Micro servo motor, Breadboard, Connecting wires	Design and Implementation of IoT project for Engineering applications

TEXT BOOK

1. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On- Approach " Second edition 2014, ISBN: 978 0996025515.

REFERENCE BOOK

2. Raj Kamal," Internet of Things: Architecture & design Principle", McGraw Hill Education, 2017.

SWAYAM/NPTEL/MOOCs

1. https://www.coursera.org/learn/iot
2. https://www.coursera.org/learn/interface-with-arduino

SELF-LEARNING EXERCISES:

a) Create Arduino project hub

Course Title	**Computer Aided Engineering Drawing**				**Course Type**		**Hard Core**	
Course Code	**B20ME0101**	**Credits**	**3**		**Class**		**I Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**4**	**4**	**26**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Engineering Graphics or drawing is known as language of engineers. All phases of engineering process require the conversion of new ideas and design concepts into the basic line language of graphics. There are many areas such as civil, mechanical, electrical, architectural, computer, electronics and industrial applications where knowledge and skills of the drawing play major roles in the design and development of new products or construction. This course emphasizes on projection of point, line, surfaces and solids. It also provides knowledge about representing the object in terms of 3d view and also development of the object.

COURSE OBJECTIVES

1. To introduce the students to various concepts like dimensioning, conventions and standards of engineering drawings in order to become professionally efficient
2. To enable students to learn about the software tool to prepare engineering drawings
3. To teach the students about the concepts and principles of orthographic projections, development of lateral surfaces and isometric projection of simple solids
4. To communicate the concept/idea with others through the language of technical drawing and sketching.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Draw orthographic projection of point, line manually and also by using CAD software.	1,2,5,10	1
CO2	Draw orthographic projection of plane surfaces manually and also by using CAD software.	1,2,5, 10	1
CO3	Draw orthographic projection of simple solids manually and also by using CAD software.	1,2,5, 10	1
CO4	Draw sectional views and development diagram of prisms, pyramids, cone and cylinder manually and also by using CAD software.	1,2,5, 10	1
CO5	Create isometric view of the solids manually and also by using CAD software.	1,2,3,5,10	1

BLOOM'S LEVELOF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4				√		
CO5				√		

COURSE ARTICULATION MATRIX

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1			2					3			3		
CO2	3	2			2					3			3		
CO3	3	2			2					3			3		
CO4	3	2			2					3			3		
CO5	3	2	2		2					3			3		
Average	3	1.8	2		2					3			3		

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Introduction: Geometrical constructions, engineering drawing standards, Introduction to CAD Software. Orthographic projection of points in first and third Quadrant only. Orthographic projection of straight lines inclined to both horizontal and vertical planes. Orthographic projection of regular plane surfaces when the surface is inclined to both HP and VP.

Unit-2

Orthographic projection of regular solids like prisms, pyramids cone and cylinder when the axis is inclined to both HP and VP.

Unit-3

Sections of solids: Drawing sectional views and true shape of section, Development of surfaces- Parallel line method for prisms and cylinders, Radial line method for pyramids and cones.

Unit-4

Isometric projections of simple and combined solids.

PRACTICE:

Sl. No	Practice	Tools and Techniques	Expected Skill /Ability
1.	Use of solid edge software and familiarization of tools	Solid Edge Software	Use of commands to draw the drawings
2.	Draw the projection of point locating in first and third quadrant	Solid Edge Software	Analyzing and software skill
3.	Draw the projection of lines locating in first quadrant	Solid Edge Software	Draw the views of the line and software skill
4.	Draw the projection of rectangular and pentagonal lamina inclined to both HP and VP	Solid Edge Software	analyzing and software skill
5.	Draw the projection of hexagonal and circular lamina inclined to both HP and VP	Solid Edge Software	analyzing and software skill
6.	Draw the projection of prisms inclined to both HP and VP	Solid Edge Software	Interpretation and software skill
7.	Draw the projection of pyramids inclined to both HP and VP	Solid Edge Software	Interpretation and software skill
8.	Draw the projection of cone and cylinder inclined to both HP and VP	Solid Edge Software	Interpretation and software skill
9	Draw the projection of section of solids in simple position	Solid Edge Software	Analyzing and Software Skill
10	Develop the lateral surface of prisms and cylinder	Solid Edge Software	Creative and Software Skill
11	Develop the lateral surface of pyramids and cone	Solid Edge Software	Creative and Software Skill
12	Draw the isometric projection of simple plane surface and simple solids	Solid Edge Software	Analyzing and software skill
13	Draw the isometric projection of two co-axial solids	Solid Edge Software	Analyzing and software skill

TEXT BOOKS

1. K S Narayanswamy and Mahesh L, “Engineering Drawing”, WILEY Publishers, 2017, ISBN: 978-81-265-7004-1.
2. K. R. Gopalakrishna, “Engineering Graphics”, Subhas Publications, 2012.
3. Bhatt N.D., Panchal V.M. & Ingle P.R, “Engineering Drawing”, Charotar Publishing House, 2014.

REFERENCE BOOKS

1. Luzadder and Duff, “Fundamental of Engineering Drawing”, Printice Hall of India Pvt. Ltd. 11th Edition, 2001.
2. Shah, M.B. and Rana B.C., “Engineering Drawing and Computer Graphics”, Pearson Education, 2008.

SWAYAM/NPTEL/MOOCS:

1. https://nptel.ac.in/courses/112/103/112103019/
2. https://www.udemy.com/course/ed/

2nd Semester

Course Title	Vector Calculus and Partial Differential Equations				Course Type		FC	
Course Code	B20AS0205	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Tutorial	IA	SEE
	Tutorial	1	1	1				
	Total	**4**	**4**	**4**	**39**	**13**	**50 %**	**50 %**

COURSE OVERVIEW

This course is an essential one for civil and mechanical engineering students. This course covers the concept of vector differentiation to understand the flow problems. Further students are able to understand identifying partial differential equations and methods of solving them.

COURSE OBJECTIVE

This course enables graduating students to identify mathematical requirements and to find efficient solutions in developing applications to civil and mechanical engineering problems.

COURSE OUTCOMES (Cos):

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Apply partial derivatives to calculate rates of change of multivariate functions.	1, 2,	1
CO2	Analyze motion problems from real lines to curves and surfaces in 3-D. Tools such as directional derivatives, divergence and curl of vector and gradient play significant roles in many applications.	1, 2	1
CO3	Interpreting line and multiple vector integral and its applications to evaluate multiple integrals involving physical phenomenon.	1, 2	1
CO4	Implementing Mathematical models of physical phenomenon involving more than one independent variable often include partial differential equations. They also arise in such diverse area as epidemiology, traffic flow studies and the analysis of economics.	1, 2	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√	√		√	
CO2		√	√		√	
CO3	√	√	√		√	
CO4		√	√		√	

COURSE ARTICULATION MATRIX

CO / Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											1		
CO2	3	2											1		
CO3	3	2											1		

CO4	3	2											1		
Average	3	2											1		

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1:

Partial Derivatives and Multiple Integrals: Functions of several variables – Partial derivatives, Homogeneous Functions – Euler's theorem, Jacobians. Multiple Integrals – Double integrals – Change of order and change of variables. Triple integrals Illustrative examples for change of order and change of variables. Gamma and Beta functions with simple examples. Engineering applications.

Unit –2

Vector Calculus: Differentiation of Vectors, Curves in space, Velocity and Acceleration, Tangential and normal acceleration, Relative velocity and acceleration, Scalar and vector point functions- Vector operator del. Del applied to scalar point functions – Gradient, Del applied to Vector point function – Divergence and Curl. Engineering applications.

Unit -3

Vector integration: Line integral – Circulation – work, Surface integral – Flux, Green's Theorem in the Plane, Stokes Theorem, Volume Integral, Divergence Theorem, Green's Theorem, Irrotational and Solenoidal Fields, Orthogonal Curvilinear Coordinates. Engineering Applications.

Unit -4

Partial Differential Equations: Formation of partial differential equations, solutions of non-homogeneous PDE by direct integration, Solutions of homogeneous PDE involving derivatives with respect to one independent variable, solution of Lagrange's Linear PDE, Solutions of PDE by product method, Engineering Applications.

TEXT BOOKS

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th Reprint edition, 2013.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th edition, 2013.

REFERENCE BOOKS

1. P.V. O'Neil, "Advanced Engineering Mathematics", Cengage Learning, 7th Edition, 2012.
2. Potter and Goldberg, "Mathematical Methods", Printice Hall of India Pvt. Ltd.

JOURNALS/MAGAZINES:

1. https://www.journals.elsevier.com/partial-differential-equations-in-applied-mathematics/
2. https://www.elsevier.com/books/vector-calculus/cox/978-0-08-057295-6

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/learn/calculus-and-optimization-for-machine-learning
2. https://www.coursera.org/learn/vector-calculus-engineers.
3. https://www.coursera.org/learn/differential-equations-engineers

Course Title	**Applied Chemistry**				**Course Type**		**FC**	
Course Code	**B20AS0201**	**Credits**	**3**		**Class**		**II semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Applied chemistry covers very relevant topics compatible with Civil engineering students and make them aware of importance of various aspects of basic science in engineering. The subject of applied chemistry covers area of water technology, corrosion phenomenon, which is widely an interdisciplinary subject of discussion. Further the course focus on the corrosion phenomenon, and various methods to control it. This area of science is very much

interdisciplinary in its nature and gives a platform for students to strengthen their engineering knowledge of corrosion in higher semester. The present applied chemistry course further enlightens on the energy conversion and storage devices, which have become very attractive field of research in engineering stream. The subject deals with various engineering materials, their properties and applications in the field of engineering.

COURSE OBJECTIVES

The Applied chemistry course is designed to fulfill the following objective;

1. To impart knowledge about the significance of water chemistry and various methods of water treatment.
2. To provide information on electrochemical concepts of corrosion science and engineering.
3. Highlights on energy storage devices and other renewable energy sources and their applications.
4. Introduction to engineering materials, properties and their applications.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe properties of water and various methods employed in water treatment.	1	1
CO2	Explain the corrosion phenomenon and account for methods used in its control.	1	1
CO3	Categorize and explain construction and working of energy storage and conversion devices.	1, 2	1
CO4	Understand common use of metals and alloys, ceramics, polymers, their composition, properties and engineering applications.	1	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3		✓				
CO4	✓					

COURSE ARTICULATION MATRIX

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												1		
CO2	2												1		
CO3	1	1											1		
CO4	2												1		
Average	1.8	1											1		

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Water Technology: Sources of water, Impurities of water, Hardness & its determination (EDTA method), Boiler Troubles & their removal, water softening methods -Lime soda, Zeolite & Ion exchange, Desalination of water — Electro dialysis & Reverse osmosis method, Chemical analysis of water

Unit-2

Corrosion: Definition, Examples, Types, Theory of corrosion, Dry corrosion (Direct chemical Attack), Wet corrosion (electrochemical attack), Mechanism of wet corrosion, Factors affecting corrosion, Corrosion Control methods, protective coatings — Metallic & organic type.

Unit-3

Energy devices: Batteries & types, fuel cell, super capacitors, photo voltaic cell.

Unit-4

Materials: Metals & Alloys: Classification and properties of iron, Steel, Nickel, Chromium, Tungsten & alloys.

Modern materials: Classification, properties, and compositions: polymers, biomaterials, glass, cement, ceramics, composite materials, Nano materials, thin films, liquid crystals.

TEXT BOOKS

1. R.V.Gadag and Nithyanandashetty, "Engineering Chemistry", Ik International Publishing house.
2. S.S. Dara, "Text Book of Engineering Chemistry", S. Chand & Co.

REFERENCE BOOKS

1. P.W. Atkins, "Physical Chemistry", Oxford Publisher, 5thedition.
2. Callister W.D., "Materials Science and Engineering", John Wiley & Sons.

JOURNALS/MAGAZINES:

1. https://www.sciencedirect.com/journal/water-science-and-technology
2. https://iwaponline.com/wst
3. https://www.scitechnol.com/nanomaterials-molecular-nanotechnology.php
4. https://www.journals.elsevier.com/journal-of-energy-storage

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/105/105/105105201/
2. https://nptel.ac.in/courses/112/108/112108150/

<table>
<tr><td>Course Title</td><td colspan="4">Introduction to Python Programming</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20CI0101</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">II Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>4</td><td>4</td><td>26</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Python is a Programming Language that can be treated in a procedural way, an object-orientated way or a functional way. It can be used on a server to create web applications, create workflows, connect to database systems, read and modify files, handle big data and perform complex mathematics. It can implement object oriented features and exception handling, It can parse the strings using regular expressions. It can be used for implementing the machine learning algorithms to develop solutions for interdisciplinary problems apart from any general problems leading to automation.

COURSE OBJECTIVES

The objectives of this course are to:

1. Explain the fundamentals of python programming language constructs and their applications.

2. Inculcate knowledge of parsing of regular expressions and their usage in various application domains.
3. Gain expertise in Object oriented programming and NumPy package.
4. Discuss the files, Pandas and Data Virtualization concepts.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Make use of fundamentals of python programming to solve real world problems.	1 to 4, 8, 9 , 12	1
CO2	Develop solutions for text processing and other application domains by making use of regular expressions.	1 to 3, 5,9,12	1
CO3	Apply features of object oriented and NumPy package to develop computationally intensive applications to analyze and interpret the data.	1 to 5, 9, 12	2
CO4	Create data science solutions with the help of files, Pandas and Data Visualization.	1,4,5,9,12	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4			√	√	√	√

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1		3	
CO3	3	1	2	1	2				1			1			3
CO4	3			2	2				1			1	3	3	3
Average	3	1.3	2	1.7	2			1	1			1	3	3	3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Introduction to Computer Fundamentals: Computer Components, accessories, specifications of computers and external devices. Flowchart symbols and guidelines, types and advantages, Algorithm design.

Python Fundamentals: Introduction to Python: History, Applications, Your First Python Program, Constants, Variables, Naming conventions, simple data types, Type casting, Assignment statements, expressions, Boolean data type, Trigonometry functions, operators, precedence of operators, libraries, keywords, Python Collections, I/O statements, conditional statements, loops, functions, user defined functions. Introduction to GitHub and applications.

Unit-2

Strings: Unicode, Formatting Strings, Format Specifiers, other Common String Methods, Slicing a String.

Regular Expressions: Case Study: Street Addresses, Case Study: Roman Numerals, Checking for Thousands, Checking for Hundreds, Using the {n, m} Syntax, Checking for Tens and Ones.

Unit-3

Object Oriented Programming: Defining Classes, The init () Method, Instantiating Classes, OOP features: Abstraction. Encapsulation, Single Inheritance, Polymorphism.

Files: Reading from Text Files, Writing to text files, Reading and Writing the Binary Files.

Unit-4

Numpy: Introduction to numpy, Creating arrays, Indexing Arrays, Array Transposition, Universal Array Function, Array Processing, Array Input and Output.

Pandas and Data Visualization: Introduction, Series and Data Frames in pandas and Data Visualization.

PRACTICE:

Sl.No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1.	a). "LIST1" is a list that contains "N" different SRN of students read using a user defined function with the help of input () function. It is required to add SRN of "M" more students that are to be appended or inserted into "LIST1" at the appropriate place. The program must return the index of the SRN entered by user.	Windows/Linux OS, IDE, Jupyter	Create and perform operations on list.
	b). "TUPLE1" and "TUPLE2" are two tuples that contain "N" values of different data types read using the user defined function "READ" with the help of input() function. Elements of "TUPLE1" and "TUPLE2" are to be read one at a time and the "larger" value among them should be placed into "TUPLE3". Display all tuples.	Windows/Linux OS, IDE, Jupyter	Create and perform operations on Tuples.
2.	a).SET1 and SET2 are two sets that contain unique integers. SET3 is to be created by taking the union or intersection of SET1 and SET2 using the user defined function Operation (). Perform either union or intersection by reading choice from user. Do not use built in functions union () and intersection () and also the operators "|" and "&".	Windows/Linux OS, IDE, Jupyter	Create and perform Union and Intersection, Operations on Sets.
	b).The Dictionary "DICT1" contains N Elements and each element in dictionary has the operator as the KEY and operand's as VALUES. Perform the operations on operands using operators stored as keys. Display the results of all operations.		Create dictionary and perform operation using user defined function.
3.	a).A substring "Substr" between index1 and index2 is to be extracted from the given input string "Str1", which is read using input (). Display the substring "Substr" using a user defined function if available in string "Str1", otherwise display NULL.	Windows/Linux OS, IDE, Jupyter	String operations.
	b) A string containing multiple words is to be read from the user one at a time, after reading perform following operations. i) Convert all the strings to uppercase and display ii) Split the words of a string using space as the separation character and display.		
	a).Consider the text file, "Std.txt", with the details of students like SRN, NAME, SEMESTER, SECTION AND AVG_MARKS.	Windows/Linux OS, IDE, Jupyter	File Handling.

Sl.No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
4.	Read the file, "Std.txt" and display the details of all the students of 4th Semester "A" Section who have scored more than 75%.		
	b).Consider the text file "Emp.txt", with the details of Employees like EMP_CODE, EMP_NAME, BASIC_SALARY, DA, GROSS_SALARY, NET_SALARY, LIC, PF and TOTAL-DEDUCTIONS. Read EMP_CODE, EMP_NAME, BASIC_SALARY, DA, LIC and PF from the user using input() and compute the following: i) TOTAL_DEDUCTIONS= (LIC+PF) ii) GROSS_SALARY= BASIC_SALARY+ DA iii) NET_SALARY= GROSS_SALARY – TOTAL_DEDUCTIONS. Write the above data to file for each employee. Read the content of "Emp.txt" and display the details of each employee.		File Handling.
5.	a). A "CAR" has the attributes COMPANY_NAME, MODEL, COLOR, MANUFACUTING_YEAR and PRICE. A Class is required to be created for "CAR" to store the above attributes and perform the following operations: i) Get the details of "CAR" object from user and store into Array of objects ii) Display the details of "CAR" object based on "COMPANY", "MODEL" and "PRICE".	Windows/Linux OS, IDE, Jupyter	Classes and objects usage.
	b). Airline Reservation System contains the attributes of passengers such as NAME, PAN_NO. MOBILE_NO, EMAIL_ID, SOURCE, DESTINATION, SEAT-NO, AIR-FARE and TRAVEL_DATE. A Class is required to be created for "Airlilne" with the above attributes and perform the following operations: i) Get the details of "Airline" object from user and store into Array of objects ii) List details of all the passengers who travelled From "Bengaluru to London". iii) List details of all the passengers who travelled From "Chicago to Beijing" on 10th of Feb, 2020.		
6.	a). "Arr_1" is an integer array of size M x N. Size and content of the array is to be read using input () by using the user defined function READ_DATA (). It is required to display the i) Diagonal elements of "Arr_1" ii) Elements of m^{th} row (row no should be entered by user) iii) Elements of n^{th} column (column no should be entered by user)	Windows/Linux OS, IDE, Jupyter	NumPy arrays usability.

Sl.No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	b).The dictionary "DICT1" contains the pass percentage of each semester of B. Tech in CSE, where, " Semester" acts as the key and "Pass Percentage" acts as the value. A Python Pandas data frame is required to be created using the dictionary "DICT1" and display it using a user defined function.		Pandas Series usability.
	Part-B (Mini Project: Library Management System)		
1.	Develop a program to create the class "USER" with the attributes USER_NAME, USER_ID, SCHOOL_NAME, ADDRESS, PHONE_NO, EMAIL_ID, DOB and AGE. The functions add_ user (), delete user (), edit user (), search user () should be part of the class. Instantiate "User" class with 10 objects. Read the attributes of each "User" object using input () and store them in the file "User_File.txt".	Windows/Linux OS, IDE, Jupyter	Create a class user to read the attributes of user and store them in a file.
2	Develop a program to get the name of the "User" object whose details are to be deleted. Read the "User_File.txt" and delete the "User" object if found. Display the contents of "User_File.txt" after deletion.	Windows/Linux OS, IDE, Jupyter	Create a class user to read the attributes and delete the object.
3	Develop a program to get the name of the "User" object whose details are to be edited (modified). Edit the details of the user object in the file "User_File.txt" and display the contents after modification.	Windows/Linux OS, IDE, Jupyter	To create a class and edit the file.
4	Develop a program to create the class "BOOK" with the attributes TITLE, AUTHOR, PUBLISHER, YEAR, PRICE, SCHOOL_NAME and the functions add book(), delete book(), edit book() and search book(). Instantiate "Book" class with 10 objects. Read the attributes of each "BOOK" object using input () and store them in the file "Book_File.txt".	Windows/Linux OS, IDE, Jupyter	Create a class book to read the attributes of user and store them in a file.
5	Develop a program to get the name of the "BOOK" object whose details are to be deleted. Read the "Book_File.txt" and delete the "BOOK" object whose details match with the data entered. Display the contents of "Book_File.txt" after deletion.	Windows/Linux OS, IDE, Jupyter	Create a class book to read the attributes and delete the object.
6	Develop a program to get the name of the "BOOK" object whose details are to be edited (modified). Edit the details of the "Book" object in the file "Book_File.txt" and display the contents after modification.	Windows/Linux OS, IDE, Jupyter	To create a class and edit the file.
7	Develop a program to create the class "TRANSACTION" with the attributes USER_ID, USER_NAME, AUTHOR, TITLE, EDITION, ISSUE_DATE,DUE_DATE and RETURN_DATE and the functions issue book(), return book() and search book(). Instantiate "Transaction" class with 10 objects. Read the attributes of each "Transaction" object using input () and store them in the file "TransactionFile.txt". Develop a program to issue the book as requested by the user. Update	Windows/Linux OS, IDE, Jupyter	Create class and perform string operations.

Sl.No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	the attributes in "Transaction _File" and display the contents of file.		
8	Develop a program to return the book. Edit the details of the user like USER_ID, USER_NAME, AUTHOR, TITLE, EDITION, ISSUE_DATE, DUE_DATE and RETURN_DATE in "TransactionFile.txt" and display the contents after modification. Compute the fine amount to be paid if return date is not same as due date. If both return date and due date are same and put zero in fine amount.	Windows/Linux OS, IDE, Jupyter	Create class and perform string operation.
9	Develop a program to search for a book using its "author". Display the message "available" if search is successful otherwise display the message "not available".	Windows/Linux OS, IDE, Jupyter	Create class and object, perform file operations and regular expressions.
10	Develop a program to get a list of users by referring to "User_File.txt" and "Transaction_File.txt".	Windows/Linux OS, IDE, Jupyter	Create class and object, perform file operations and regular expressions.
11	Develop a program to get List of Books in stock by referring to "Book_File.txt" and "Transaction_File.txt".	Windows/Linux OS, IDE, Jupyter	Create class and object, perform file operations and regular expressions.
12	Develop a program to get List of Books Issued by referring to "User File", "Book File" and "Transaction File".	Windows/Linux OS, IDE, Jupyter	Create class and object, perform file operations and regular expressions.
13	Develop a project by integrating User, Books, Transaction and Reports Modules.	Windows/Linux OS, IDE, Jupyter	Module integration and project development.

TEXT BOOKS

1. Mark Pilgrim, "Dive into Python 3", Apress Special Edition, 2nd Edition, 20l5.
2. Travis E. Oliphant, "Guide to NumPy", Trelgol Publishers, 2006.

REFERENCE BOOKS

1. A B Choudhary, "Flowchart and Algorithms Basics", Mercury Learning and Information, 2020.
2. Mark Lutz, "Learning Python", Oreilly, 2003.
3. John M. Zelle, "PYTHON Programming: An Introduction to Computer Science", Franklin, Beedle & Associates. 2004.
4. Michael Dawson, "Python Programming for the Absolute Beginners", CENAGE Learning, 3rd Edition.
5. Wesley J. Chun, "Core Python Programming", Prentice Hall, 2nd Edition.
6. Steve Holden and David Beazley, "Python Web Programming", New Riders Publishers, 2002.
7. Kent D. Lee, "Python Programming Fundamentals", Springer, 2nd Edition.
8. John V. Guttag, "Introduction to Computation and Programming using Python", MIT Press, 2016.
9. https://www.tutorialspoint.com/computer_fundamentals/computer_fundamentals_tutorial.pdf

JOURNALS/MAGAZINES

1. https://www.codemag.com/Magazine/ByCategory/Python
2. http://ijaerd.com/papers/special_papers/IT032.pdf
3. https://iopscience.iop.org/article/10.1088/1742-6596/423/1/012027
4. https://ieeexplore.ieee.org/document/4160250

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

SWAYAM / NPTEL / MOOCs:

1. Coursera – Python for everybody, University of Michigan
2. Coursera – Python Basics, University of Michigan
3. https://nptel.ac.in/courses/106/106/106106182/
4. https://www.edx.org/learn/python

Course Title	Basic Electrical and Electronics Engineering				Course Type		Hard Core	
Course Code	B20EE0101	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory Hours	Practical Hours	IA	SEE
	Tutorial	0	0	0				
	Total	**4**	**5**	**4**	**39**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Basic Electrical & Electronics Engineering covers basic concepts of electrical engineering and electromagnetism. This course introduces the student to the working AC and DC Machines. It also helps the student to understand the basics in digital electronics by applying the knowledge of logic gates and learning the applications of diodes in rectifiers, filter circuits. Further, it has a self-learning component on BJT's.

COURSE OBJECTIVES

1. Explain the basics of electrical and electronics engineering terminologies.
2. Distinguish the single and three phase systems.
3. Illustrate the different building blocks in digital electronics using logic gates and explain simple logic functions using basic universal gates.
4. Discuss the applications of diode in rectifiers, filter circuits and wave shaping.
5. To build a broad concept for hands on experience in various types of electrical apparatus, tools and instrumentation with electrical safety norms.
6. To analyze the schematics for making electrical connection and to interpret experimental data for various electrical appliances.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Summarize the basics of electrical engineering terminology and the usage.	1,2	1
CO2	Analyze the concepts and applications of DC & AC Machines.	1,2	1
CO3	Apply the concept of domestic wiring, importance of safety and sensing devices	1,2,10	1
CO4	Analyze the different building blocks in digital electronics using logic gates and applications of diode in rectifiers, filter circuits and wave shaping. .	1,2	1
CO5	Interpret, Identify and use appropriate electrical tools for electrical connections and to repair electrical equipment's	1,2,9,10	1,2
CO6	Compare experimental results with theoretical analysis and the ability to critically evaluate the performance of electrical appliances.	1,2,9,10	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√				
CO2				√		

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CO3			√			
CO4				√		
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO / Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1											1		
CO2	1	1											1		
CO3	2	2								2			1		
CO4	3	1											1		
CO5	2	2							3	1			3	3	
CO6	2	2							3	1			3	3	
Average	2	1.5							3	1.3			1.7	3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Electrical Circuits: Basic definitions, Types of elements, Ohm's Law, Kirchhoff's Laws, Resistive, Inductive, capacitive networks, Series, Parallel circuits and Star-delta and delta-star transformations, Network Theorems (Superposition, Thevenin's & Norton's) Generation of an alternating Emf–average and rms values of alternating quantity–representation of alternating quantities by phasors–single phase series and parallel circuits (simple problems), three phase systems and power calculations.

Unit-2

DC-Machines: Construction and Principle of operation of DC Machines–Emf & Speed equations-types–applications. AC-Machines: Principle of operation of single phase transformers–Emf equation–losses–efficiency and regulation-Construction and working principle of induction motors–Slip–torque characteristics–applications-Construction and Principle of operation of alternators applications.

Unit-3

Instruments: Basic Principle of indicating instruments–PMMC&MI instruments. Tariff, Protective Devices and Sensors: Tariff schemes, basic concepts of domestic wiring and types, Earthing, protective fuses, MCB, sensors: pressure sensors, strain gage, proximity sensors, displacement sensors, Rotatory encoder and ultrasonic sensors and civil engineering applications.

Unit-4

Diodes: Introduction, Physical operation of p-n junction diodes, Characteristics of p-n junction diodes, Zener diode, Rectifier circuits (half-wave, full-wave, bridge and peak rectifiers),Light emitting diodes.

Digital Electronic Principles: Introduction, Binary digits, Logic levels and Digital waveforms, Introduction to basic logic operation, Number system, Decimal numbers, Binary numbers, Decimal-to-Binary conversion, Simple binary arithmetic.

PRACTICE:

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Electrical Safety Training. a) To Study the importance of Earthing during accidental shorting of line wire and the body of equipment.	Trainer kit	Importance & applications of Earthing, Fuse & MCB

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	b) To conduct experiment and to know the Importance and mechanism of FUSE	Ohms Law Fall of resistance	
	c) To study the Importance and mechanism of MCB.		
2.	Home Electrical Wiring Demonstration. a) To study & verify the connection procedure for fluorescent lamp wiring.	Fluorescent Lamp wiring Panel Fan with switch and regulator Kit	Connection & Trouble shooting of Fluorescent lamp wiring & Fan with switch and regulator
	b) To study the connection of Fan with switch and regulator.		
3.	Two-way switch/ staircase wiring. To study & verify the connection procedure for two-way switch or staircase wiring	Two-way switch or staircase wiring Kit	Connection, Working & application of Two-way switch
4.	Behaviour of current and voltage in series and parallel circuits. a) To study and verify the 71ehavior of current and voltage in series circuit.	Series and parallel circuits Kit	Connection & 71ehavior of current & voltage in series , parallel circuit
	b) To study and verify the 71ehavior of current and voltage in parallel circuit.		
5.	Polarity test on single phase transformer. a) To determine the additive polarity of a single-phase transformer.	Transformer Kit	Polarities of single phase transformer
	b) To determine the subtractive polarity of a single-phase transformer.		
6.	Determination of VI characteristics of Zener Diode	VI characteristics of Zener Diode kit	VI characteristics of Zener Diode
7.	Determination of VI characteristics of Silicon Diode	VI characteristics of Silicon Diode kit	VI characteristics of Silicon Diode
8.	Analyze the Half Wave and Full Wave rectifiers using Diode with and without filter	Rectifier kit	Determine the efficiency, Voltage regulation, ripple factor of rectifiers
9.	Determine the Characteristics of BJT in Common Emitter Configuration	Characteristics of BJT in Common Emitter Configuration	Input & Output Characteristics of BJT
10.	Determine the Characteristics of JFET in Common Source Configuration	Characteristics of JFET in Common Source Configuration	Input & Output Characteristics of JFET
11.	Realization of Universal gates using basic logic gates.	Trainer kit	Universal gates will be realized using basic gates

TEXT BOOKS

1. Nagrath I.J. and D. P. Kothari, “Basic Electrical Engineering”, Tata McGraw Hill, 3rd Edition 2009.
2. Hayt and Kimberly, “Engineering Circuit Analysis”, Tata McGraw Hill, 8th Edition, 2013.
3. Kulshreshtha D.C., “Basic Electrical Engineering”, Tata McGraw Hill, 2009.
4. Rajendra Prasad, “Fundamentals of Electrical Engineering”, Prentice Hall, India, 2009.

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

5. Hughes, E., "Electrical Technology", Pearson, 2005.
6. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 2008.
7. D.P. Kothari, I. J. Nagrath, "Basic Electronics", McGraw Hill Education (India) Private Limited, 2014.

REFERENCE BOOKS

1. Theodore Wildi, "Electrical Machines, Drives and Power", Pearson Prentice Hall, 5th Edition, 2007.
2. Hughes, "Electrical Technology", Addison Wesley Longman Limited, 9th Edition, 2005.

JOURNALS/MAGAZINES

1. International Journal of Electrical Power and Energy Systems (https://www.journals.elsevier.com/international-journal-of-electrical-power-and-energy-systems)
2. Journal of Electrical Engineering (https://link.springer.com/journal/202)

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/108/108/108108076/

Course Title	Elements of Mechanical Engineering				Course Type		Hard Core	
Course Code	B20ER0201	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**4**	**5**	**5**	**39**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Elements of Mechanical Engineering is a basic course of Mechanical Engineering discipline. It focuses on overall view of mechanical engineering area's like thermal, design and manufacturing streams. The course is designed to understand basic concept like formation of steam and compute the steam properties like specific volume, enthalpy, and internal energy using steam tables. The students are introduced to internal combustion engines, turbines (water, steam and gas) and refrigeration-air conditioning system. The students will be imparted to calculate BP, IP, mechanical efficiency of IC engines. The students are exposed to the machine elements like springs, belt drives and gear drives. Acquainted with different machine tools like lathe, drilling machines and CNC machines. The students will be exposed to joining processes like Soldering, Brazing and Welding and various power transmission systems. Students are introduced to the engineering materials and modern manufacturing Technology like 3D printing technology.

COURSE OBJECTIVES

1. To develop the basic knowledge on heat & work, steam formation, working principle of boilers, turbines, IC engines and refrigeration – air conditioning systems
2. To incorporate the concept of different types of machine elements like springs, belt drives & chain drives
3. To give exposure in the field of engineering materials and manufacturing processes
4. To incorporate the concepts of modern manufacturing processes like CNC, 3D printing technology and its applications

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Describe the concepts of heat & work, steam formation, properties, working principle of boilers, turbines, IC engines and refrigeration – air conditioning systems	1,2,3,9,10	1,2
CO2	Explain the machine elements types and applications and Solve the numerical based on gear & belt drives.	1,2	1,2
CO3	Compare the different kinds of machine tools and select the suitable machine tool for processing the materials and different metal joining process for the different applications	1,2,3,9,10	1,2

CO4	Classify the engineering materials and discuss the concept of casting, CNC and 3D printing technology	1,2,3,5	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3				√		
CO4		√				

COURSE ARTICULATION MATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1						2	1			1	2	
CO2	3	2											1	3	
CO3	3	2	1						2	1			3	1	
CO4	3	2	1		1								2	1	
Average	3	2	1		1				2	1			1.8	1.8	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Introduction to Energy Systems: Concept of heat and work, Steam formation, Types of steam, Steam properties. Introduction to boilers, working of Babcock and Wilcox boiler.

Unit-2

Prime Movers: Types and working principle of turbines and IC Engines.

Introduction to Refrigeration and Air Conditioning: Working principle of refrigeration system, working of domestic refrigerator and window air conditioner

Unit-3

Machine Elements: Types and applications of springs, belt drives, gear drives and chain drives, Numerical on belt drives and gear drives.

Unit-4

Materials and Manufacturing Processes: Introduction to engineering materials and classifications, casting, Machine Tools- lathe & drilling machine, metal joining process-welding, brazing and soldering, modern manufacturing technology-CNC machines and 3D printing.

PRACTICE

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Dismantling and Assembly of 2-Wheeler (2–stroke) Engine	2-Stroke Engine	Hands on Experience
2.	Identification of parts of an engine of Toyota Innova and Toyota Fortuner	Toyota Engine	Hands on Experience
3.	Calculation of Speed ratio of belt, chain and gear drives		Thinking Skill

4.	Study of Power train of Bicycle, 2-Wheeler and 4-Wheeler	Engines	Hands on Experience
5	Study of Fitting tools and preparation of fitting models(2 Models)	Fitting tools	Hands on experience
6	Study of sheet metal tools and development of pen stand and funnel	Sheet metal tools and soldering tools	Creative Thinking
7	Hands on training on basic welding joints	Welding tools	Hands on experience
8	Preparations of welding models like 3-Legged table, 4-legged table, Name boards, Window frame etc.	Welding tools	Creative Thinking & team work

TEXT BOOKS

1. K.R. Gopalkrishna, "Elements of Mechanical Engineering", Subhash Publishers, 12th Edition, 2012.
2. Roy & Choudhury, "Elements of Mechanical Engineering", Media Promoters & Publishers Pvt. Ltd, 2000.

REFERENCE BOOK

1. SKH Chowdhary, AKH Chowdhary and Nirjhar Roy, "The Elements of Workshop Technology - Vol I & II", Media Promotors and publisher, 11th edition, 2001.

JOURNALS/MAGAZINES

1. International Journal of Machine Tools and Manufacture
2. International Journal of Refrigeration.

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/browse/physical-science-and-engineering/mechanical-engineering
2. https://www.my-mooc.com/en/categorie/mechanical-engineering
3. https://nptel.ac.in/cours

Course Title	**Biology for Engineers**				**Course Type**		**FC**	
Course Code	**B20AS0109**	**Credits**	**1**		**Class**		**II Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**1**	**1**	**13**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Understanding biological systems, principles and concepts in order to create usable, tangible, economically viable product or process has become need of the hour. Hence irrespective of the parent engineering discipline, knowledge and expertise from pure and applied sciences is necessary to create product or process related to healthcare, agriculture, environmental issues and many more. Any engineer will have a high probability of using biology related skills and concepts to create products and processes beneficial to the mankind and as well for the sustainable environmental friendly approach. For example, the knowledge can be used to create medical devices, diagnostic equipment's, bioreactor designing, agriculture related equipment/instruments or anything related to surface science, fluid mechanism and polymer science. This course is designed to lay foundation in the field of Cell biology, Molecular biology and Genetics, so that anyone who is interested can design better product/process to enhance the overall quality of life.

COURSE OBJECTIVES

1. To inculcate the basic concepts of biology from engineering perspective among students
2. To understand the interplay between biology and engineering disciplines
3. To conceptualize the engineering design/process/product for life science challenges

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Understand the biology concepts from engineering perspective.	1	1
CO2	Develop process/product related to the field of Life Sciences.	1,3	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√				
CO2	√	√	√			

COURSE ARTICULATION MATRIX

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2					1	1								
CO2	2	2				1	1								
Average	2	2				1	1								

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Introduction to Biology, Evolution and Origin of Life, Biomolecules-Lipids, Biomolecules: Carbohydrates, Water, Biomolecules: Amino acids, Proteins, Biomolecules: Enzymes, Biomolecules: Nucleotides

Unit-2

Cell structure and function – Prokaryotes, Cell structure and function – Eukaryotes, Cell cycle-Mitosis and Meiosis, Mendelian genetics: Mendelian inheritance, Genetic diseases and Mendelian inheritance, Central Dogma – Replication, Transcription and Translation.

TEXT BOOKS

1. G.K. Suraishkumar, "Biology for Engineers", Oxford University Press, 2019
2. Biology for Engineers, As per AICTE curriculum, Wiley publication,
3. Dr.Sohini Singh and Dr.Tanu Allen, "Biology for Engineers", Vayu Education of India

REFERENCE BOOKS

1. P.S.Verma and V.K. Agarwal, "Cell Biology, Genetics, Molecular Biology, Evolution and Ecology", S. Chand & Company Ltd., 2018
2. Handbook of Genetics, Sambamurthy, Friends Publisher, 2010

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc19_ge31/preview
2. Coursera: Biology everywhere

Course Title	Design Thinking				Course Type		Hard Core	
Course Code	B20ME0102	Credits	2		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**2**	**3**	**13**	**26**	**50 %**	**50 %**

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

COURSE OVERVIEW

Today, innovation is everyone's business. At every level, in every kind of organization, design thinking provides the tools that one needs to become an innovative thinker and uncover creative opportunities. For example, companies like Procter, Gamble and GE have incorporated Design Thinking into their strategy and marketing. The course draws on methods from engineering and design, and combines them with ideas from the arts, tools from the social sciences, and insights from the business world.

In this course, students start in the field, where they discover the needs of the target audience. They then iterate ideas on teams to develop a range of promising possible solutions, create rough prototypes to take back out into the field, and learn to test with real people in the target audience.

COURSE OBJECTIVES

1. To impart knowledge on design thinking process for understanding designs.
2. To provide design skills to analyze design thinking issues and apply the tools and techniques of design.
3. To inculcate attitude to solve societal problems using design thinking tools.

COURSE OUTCOMES (CO'S)

On successful completion of this course; the student shall be able to:

CO	Course Outcomes	POs	PSOs
CO1	Identify the problems that fall under the purview of human centered design process for creative problem solving.	1,2 , 9,10,12	2
CO2	Create empathy maps to visualize user attitudes and Develop innovative products or services for a customer base using ideation techniques	1,2,9,10,12	2
CO3	Build simple prototypes for problems using gathered user requirements.	1,3, 9,10,12	1,2
CO4	Improve prototype by testing it with a specific set of users for making it sustainable by following ethics.	1,4,8,9,10,12	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓					
CO2			✓			
CO3			✓			
CO4				✓		

COURSE ARTICULATION MATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2							2	2		2	3	2	
CO2	1	3							2	3		2		2	
CO3	2		3						3	3		2	2	3	
CO4	2			2				1	3	2		2	2	3	
Average	2	2.5	3	2				1	2.5	2.5		2	2.3	2.5	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Design Thinking Process:

Types of the thinking process, Design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs Design thinking. Problem Exploration, Case Studies from Embrace-Stanford Innovation Challenge, IDEO, GE Healthcare, The Good Kitchen- Denmark Program etc., identifying the target users for the problem selected, Survey on existing solutions for the problem identified.

Empathizing: Powerful Visualizing tool – a method to connect to the user, Creating Empathy maps – Case studies.

Unit-2

Defining the problems:

POV statements from User perspective. Idea generation: Methods to spark the innovative ideas – Brainstorming, Mind map, Story board, Provocation etc.

What is a prototype? – Prototyping as a mind-set, prototype examples, prototyping for products; Why we prototype? Fidelity for prototypes, Process of prototyping- Minimum Viable prototype

Prototyping for digital products: What's unique for digital, Preparation; Prototyping for physical products: What's unique for physical products, Preparation; Testing prototypes with users.

PRACTICE:

Sl. No	Name of the Practice Session	Tools and Techniques	Expected Skill /Ability
1	Identifying the problem that can be solved using Design Thinking approach	Observation and survey	Develop identifying human centered problems
2	Build the empathy maps for simple problems like single user	Visualization	Develop ability to understand other's emotions
3	Build the detailed empathy maps for problem identified in the teams formed	Visualization	Develop ability to understand other's emotions
4	Presentation by student teams	PPT	Develop ability to express their views
5	Obtain the insights into user's problems and make PoV statement	Understanding	Develop making problem statements from user perception
6	Presentation by student teams	PPT	Develop ability to express their views
7	Carry out Brain storming between the groups and generate as many as ideas possible	Ideation tools	Develop innovative mind set
8	Prototype for best 3 ideas selected	Sketching, simple model making etc.	Develop prototyping techniques
9	Presentation by student teams	PPT	Develop ability to express their plan
10	Test the developed prototype with set of identified users	Google forms , cold calls, social media etc.	Develop understanding of various testing methods
11	Pitching final solution	PPT	Develop ability to express their views

TEXT BOOKS

1. Gavin Ambrose and Paul Harris, "Basics Design-Design Thinking", AVA Publishers, 2010

2. Kathryn McElroy, “Prototyping for Designers: Developing the best Digital and Physical Products”, O’Reilly, 2017.

REFERENCE BOOKS

1. Michael G. Luchs, Scott Swan, Abbie Griffin, “Design Thinking – New Product Essentials from PDMA”, Wiley, 2015.
2. Vijay Kumar, “101 Design Methods: A Structured Approach for Driving Innovation in Your Organization”, John Wiley & Sons, 2012.

JOURNALS/MAGAZINES/ADDITIONAL SOURCES

1. Leonard, D., and Rayport, J. F. 1997. Spark Innovation through Empathic Design. In Harvard Business Review, November-December 1997, 102-113.
2. https://www.ideo.com
3. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process
4. https://www.ibm.com/design/thinking/page/toolkit
5. https://www.interaction-design.org/literature/article/define-and-frame-your-design-challenge-by-creating-your-point-of-view-and-ask-how-might-we
6. https://www.culturepartnership.eu/en/article/ten-tools-for-design-thinking
7. https://youtu.be/M66ZU2PCIcM
8. https://thisisdesignthinking.net/2017/07/innogy_energy_ecarsharing/

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/109/104/109104109/
2. https://nptel.ac.in/courses/11010612

3rd Semester

Course Title	Laplace Transforms and Fourier Series				Course Type		FC	
Course Code	B20AS0304	Credits	3		Class		III semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0			IA	SEE
	Tutorial	0	0	0	Theory	Practical		
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

In this course students will study the Laplace Transforms, inverse Laplace Transforms, Fourier Series, Fourier transforms and Numerical Methods. The purpose of this course is to provide students with skills and knowledge required to perform mathematical procedures and processes for solution of engineering problems. This course is widely used in all streams of Engineering particularly in the field of Mechanical Engineering.

COURSE OBJECTIVES

1. To impart the Knowledge of Laplace transforms and its applications in the field of engineering.
2. To impart the Knowledge of Inverse Laplace transforms and its applications in the field of engineering.
3. To study and understand the application approach of the concepts of Fourier series and transforms.
4. To study and understand the application approach of the concepts of Numerical methods.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Apply the knowledge of Laplace transformation technique to convert physical function form from the time domain to the frequency domain.	1,2,3	1
CO2	Study the periodic function, unit step function and unit impulse function by using Laplace transform.	1,2	1
CO3	Compute Inverse Laplace transform and apply them to ODEs arising in engineering	1,2	1
C04	Find the Fourier series and half range series expansion of different functions in different intervals	1,2	1
CO5	Find the Fourier & inverse Fourier transforms of different functions and apply this knowledge in solving different Mechanical engineering problems.	1,2	1
C06	Apply the numerical methods to solve various engineering problems.	1,2	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√	√		√	
CO2	√	√	√		√	
CO3	√	√	√		√	
CO4	√	√	√		√	
CO5	√	√	√		√	
CO6	√	√	√		√	

COURSE ARTICULATION MATRIX

CO / Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1										2		
CO2	3	2											2		
CO3	3	2											3		
CO4	3	2											2		
CO5	3	2											2		
CO6	3	3											3		
Average	3	2.3	1										2.3		

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Laplace Transforms: Definition, transforms of elementary functions, Properties-transform of e^{at} f(t) , t^n f(t) and f(t)/t. Laplace transform of derivatives, integrals, periodic functions, unit step function and unit impulse function.

Unit-2

Inverse Laplace Transforms: Inverse Laplace Transforms, Inverse Laplace transform of standard functions, convolution theorem (without proof), Solution of linear differential equations using Laplace Transforms.
Applications: Applications of Laplace transforms to Mechanical engineering problems.

Unit- 3

Fourier Series: Periodic functions, Dirichlet's condition, Fourier Series of periodic functions with period 2π and with arbitrary period $2l$. Fourier series of even and odd functions. Half range Fourier Series, practical harmonic analysis-Illustrative examples from engineering field.

Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Applications to Mechanical engineering problems.

Unit – 4

Numerical Methods: Numerical solution of algebraic and transcendental equations by Regula- Falsi Method and Newton-Raphson method.

Finite Differences: Forward and backward differences, Newton's forward and backward interpolation formulae. Divided differences- Newton's divided difference formula. Lagrange's interpolation formula and inverse interpolation formula (all formulae without proof)-Problems.

TEXT BOOKS

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 48th edition.
2. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 1stedition.

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 13th edition.
2. R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 4th edition.

Course Title	**Engineering Thermodynamics**				**Course Type**		**Hard Core**	
Course Code	**B20ER0301**	**Credits**	**4**		**Class**		**III semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	1	1	1				
	Total	**4**	**4**	**4**	**52**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The primary purpose of the course Engineering Thermodynamics is to provide the student with knowledge about fundamentals of thermodynamics which includes thermodynamic systems and process. Thermodynamic laws with application and expose to various thermodynamic cycles. Understand the properties of the gases and pure substances to analyze the process. Further the course exposé the students to working of the devices like compressor and refrigeration system.

COURSE OBJECTIVE

This course enables graduating students to understand the basic concepts of thermodynamics and its laws and cycles to identify, analyze formulate and solve engineering problems.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Apply fundamental concepts of thermodynamics to identify system and solve numerical on temperature thermodynamics to solve problems	1,2	1,2
CO2	Analyze the various systems by use of first and second law of thermodynamics and solve numerical by use of first and second law of thermodynamics	1,2	1,2
CO3	Solve the numerical on various thermodynamic process by applying the concept of ideal gases, real gases and pure substances	1,2,6	1.2,3
CO4	Analyze basic thermodynamic cycles of various systems	1,2	1,2,3
CO5	Solve numerical on Compressor	1,2	1,2,3
CO6	Apply the concept of refrigeration and psychometric process to solve numerical	1,2,6	1,2,3

BLOOM'S LEVELOF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√	√			
CO2			√	√		
CO3			√	√		
CO4			√	√		
CO5		√	√			
CO6		√	√			

COURSE ARTICULATIONMATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											3	3	
CO2	3	3											3	3	
CO3	3	3				1							3	3	1
CO4	3	3											3	3	1
CO5	3	3											3	3	1
CO6	3	3				1							3	3	1
Average	3	3				1							3	3	1

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Introduction: Thermodynamic systems and processes: Types, state, system, process and cycle. Thermal equilibrium, Zeroth law of thermodynamics and thermodynamic temperature scales. Work and heat: Thermodynamic definition, displacement work for various thermodynamic processes.

First Law of Thermodynamics: first law for a closed system undergoing cyclic and non-cyclic process, first law applied for open system- steady flow engineering devices

Unit-2

Second Law of Thermodynamics: Direct and reversed heat engine, Thermal efficiency, COP, Kelvin-Planck and Clausius statements, Equivalence of Kelvin-Planck and Clausius statements, entropy-definition and TdS relations. Ideal Gases and Pure Substances: Ideal gases: Definition, gas constant, perfect and semi perfect gases, Evaluation of heat, work, and change in internal energy, enthalpy and entropy for various quasi-static processes.

Pure substance: Properties of pure substance, phase transformation, saturated and superheated steam, dryness fraction, properties of dry, wet and superheated steam, Mollier diagram

Unit-3

Gas Power Cycles: Air-standard Otto, Diesel, dual and Brayton cycles,

Reciprocating compressor: Single stage and multi stage compression, volumetric efficiency, saving in work, optimum intermediate pressure, inter-cooling: perfect and imperfect, minimum work for compression.

Unit-4

Vapour Power Cycle: Thermodynamic analysis of simple Rankine cycle, methods to improve cycle performance, Regeneration (open feed water) and reheating.

Refrigeration Cycle: Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, Vapour absorption refrigeration system. Properties of moist air, psychrometric chart, basic psychrometric processes

TEXT BOOKS

1. P. K. Nag, “Basic and Applied Thermodynamics”, Tata McGraw Hill, 2nd Edition, 2009.
2. R. K. Rajput, “Thermal Engineering”, Lakshmi Publications, New Delhi, India, 18th Edition, 2011.

REFERENCE BOOKS

1. Yunus A. Cengel, “Thermodynamics: An Engineering Approach”, McGraw – Hill Education, 8th Edition, 2017.
2. S Domkundwar, C P Kothandaraman, Domkundwar, “A course in Thermal Engineering”, Dhanpat Rai Publication, New Delhi India, 6th Edition, 2009,
3. Gordon J. Van Wylan & Richard E Sonntagg, “Fundamentals of Thermodynamics”, Wiley Eastern Ltd, 7th Edition, 2009.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/the-journal-of-chemical- thermodynamics

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/112/105/112105123/
2. https://www.coursera.org/courses?query=thermodynamics

<table>
<tr><td>Course Title</td><td colspan="4">Material Science</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ER0302</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">III semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

COURSE OVERVIEW

The subject explores the structure of materials and how the structure of materials can be classified as per the materials. Material science is an interdisciplinary subject expended from side to side of physics and chemistry of matter, engineering applications and industrial manufacturing processes. The purpose of study of material science is to understand the relationship between structure and properties of a material. This course focuses of fundamentals of material, properties and applications. Topics include: crystal structures, solidification of metals and alloys, defects in materials, phase diagrams, heat treatment, corrosion, types of engineering materials and characterization techniques.

COURSE OBJECTIVES

1. To provide the basic knowledge and to enhance the knowledge of the structure of materials this includes crystallography, microstructure, defects, and diffusion.
2. To develop the knowledge about the phase diagrams, solidification, heat treatment process, stress strain diagram, mechanical properties, fracture, fatigue and creep.
3. To enhance the knowledge of iron carbon phase diagram, CCT, TTT diagrams, Hardenability, heat treatment and corrosion.
4. To incorporate the knowledge in various class of engineering materials, applications and characterization techniques.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Identify the structure of materials which includes crystallography, microstructure, defects, and diffusion.	1,2	1,2,3
CO2	Identify various phases of metals and alloys through appropriate phase diagrams and will be able to evaluate the effect of alloying elements, properties and application of ferrous and non-ferrous metals.	1,2	1,2,3
CO3	Select suitable heat treatment process based on material properties and will be to provide suitable methods to avoid corrosion	1,2	1,2,3
CO4	Suggest suitable engineering materials for different application and will be able to Correlate the structure-property relationship in metals/alloys in as-received and heat treated conditions	1,2	1,2,3
CO5	Describe the applications of super alloys, composites and nanomaterials	1	1,2,3
CO6	Choose the suitable characterization techniques for analysis of surface topography and to find out the Properties of metals and alloys	1,2,5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓			
CO3				✓		
CO4				✓		
CO5			✓			
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3	1											3	1	3
CO2	3	1											3	1	3
CO3	3	1											3	1	3
CO4	2	1											3	1	3
CO5	3	2											3	1	3
CO6	3	2			1								3	1	3
Average	2.8	1.3			1								3	1	3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Structure of crystalline solids: Basic idea of lattice, crystalline and non-crystalline materials, unit cell, crystal structure of simple cubic, BCC, FCC and HCP, coordination number, packing of atoms. Simple numerical

Defects and diffusion in solids: Point, linear, planar and volume defects, edge and screw dislocations, Burger vector, grain boundaries, twin and stacking faults. Diffusion mechanism, Fick's first law and simple numericals.

Unit-2

Phase diagrams: Isomorphous and eutectic binary phase diagrams, Gibbs phase rule concept of tie line and lever rule, equilibrium and non-equilibrium cooling, microstructure development in eutectic phase diagram. Simple numerical on phase diagrams and lever rule, Solidification of metals and alloys, nucleation and growth phenomena, heterogeneous and homogeneous nucleation,

Mechanical Properties of Materials: concept of stress and strain diagram for ductile and brittle materials, Hooks law, elastic and plastic deformation, tensile properties, fatigue, fracture and creep.

Unit-3

Iron-carbon system, Fe-Fe3C diagram, invariant reactions, different phases. Effect of alloying elements. Isothermal and continuous cooling transformation (CCT) diagrams, TTT diagrams, Hardenability; Jominy-end quench test.

Fundamentals of heat treatments of Steels. Annealing, Homogenisation. Spheroidising, Normalising, Quenching media, Austempering, Martempering, Hardening and Tempering. Age hardening of Al-Cu alloy. Corrosion: introduction, Types of corrosion; dry and wet corrosion, electro chemical and oxidation (chemical) corrosion, factors influencing corrosion.

Unit-4

Engineering materials: Introduction to polymers- properties & applications of thermoplastic engineering polymers. Ceramics- classification of ceramics, applications of ceramics. Types of glasses and their chemical compositions, Physical properties of glasses.

Composite Materials: classification of composite materials based on matrix and reinforcement, matrix and fiber materials. Different types of super alloys: properties and applications of super alloys. Nanomaterials: introduction, bottom up and top down approaches.

Introduction to optical microscopic technique and working principle, Scanning and Transmission Electron **Microscopy:** Introduction to EM, construction and working principle, the necessity of characterization using SEM and TEM techniques, Diffraction: Fundamentals of Diffraction, Bragg's law, X-ray diffraction pattern of crystalline and amorphous material.

TEXT BOOKS

1. William D. Callister, "Materials Science and Engineering", (Adopted by R. Balasubramaniam), Wiley-Eastern. 2008.
2. Raghavan V, "Materials Science and Engineering – A First Course", Prentice Hall, India, 2007.

REFERENCE BOOKS

1. James F. Shackelford, "Introduction to Materials Science for Engineers", Prentice Hall, India, 1996.

2. Askeland D.R.& P. P. Fullay, “The Science and Engineering of Materials”, 4th Cengage Learning Publishers, 2007.
3. T.V. Rajan, C.P. Sharma and Ashok Sharma, “Heat Treatment – Principles & Techniques”, Prentice Hall of India, New Delhi.
4. Charles S. Barrett &T.B. Massalski, “Structure of Metals – Crystallographic Methods, Principles & Data”, Eurasia Publishing House (Pvt.) Ltd., New Delhi.
5. B.D. Cullit, “Elements of X-ray Diffraction”, Addison – Wesley Publishing CompanyInc., USA.
6. Robert E, “Physical Metallurgy Principles”, Attiliated East-West Press PrivateLtd., New Delhi.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology
2. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/122/102/122102008/

Course Title	Manufacturing Science				Course Type		Hard Core	
Course Code	B20ER0303	Credits	4		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**4**	**5**	**5**	**39**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Manufacturing Science is a basic course of Mechanical Engineering discipline. It focuses on overall view of mechanical engineering areas of manufacturing streams. The course is designed to understand basic concept like molding, casting, welding, metal forming, sheet metal and non-conventional machining manufacturing process. The students are exposed to the molding and joining process like Soldering, Brazing and Welding and various joining process. Students are introduced to the non-conventional machining methods working principles and applications.

COURSE OBJECTIVES

1. To enable the students understand the basic concepts of moulding and the sequence of processes involved in the preparation of green sand mould and sand test.
2. To teach students how to select the metal forming processes.
3. To teach students how to perform simple welding operations using Arc.
4. To understand the use of non-conventional machining processes.
5. To help students acquire knowledge about the behaviour and manufacturing properties of all engineering materials and basic concept of foundry and casting processes.
6. To demonstrate and give hands on training on the moulding and welding process.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Describe the concepts of molding and working principle involved in casting process.	1, 10	1,2
CO2	Explain the metal forming process types and applications and Solve the numerical on forging and extrusion.	1, 9, 10	1,2
CO3	Compare the different metal joining process for the different applications	1,2	1,2
CO4	Discuss the working concept of Non-conventional machining and their applications	1,5	1,2

CO5	Demonstrate an understanding of various methods of casting process involved in manufacturing.	1,2,3,9, 10	1,2
CO6	Demonstrate to ability to solve engineering problems in welding process and manufacturing techniques for economic production.	1,2,3,9	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√			
CO4		√				
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									3			1	2	
CO2	2								3	3			1	3	
CO3	2	1											3	1	
CO4	2				1								2	1	
CO5	3	1	1						3	3			1	2	
CO6	3	1	1						3				1	2	
Average	3	1	1		1				3	3			1.5	1.8	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Metal Casting Processes: Casting Terminology, Pattern ,Types of Patterns, Pattern allowances, Moulds, Moulding Tools, Machines and Materials, Core, Core Making ,Sand Moulding methods , Melting furnaces fluxing, Inoculation, Die-casting processes-Cleaning, Inspection and repairing of castings.

Sand casting, Shell mould casting –Investment casting – Plaster mould casting – Ceramic mould casting – Die casting –Centrifugal casting – Melting practice and furnaces – Defects in casting – Testing and inspection of casting.

Unit-2

Metal Forming Processes: Hot working & Cold working of metals – Forging Machines – Forging operations– Rolling Types of Rolling mills – Rolling operations – Extrusion – Extrusion processes– Rod, wire and tube drawing – Bending – Principle & types- Deep drawing – Principle & Types Sheet metal forming operations such as squeezing, spinning, peen ,stretch forming and super plastic forming.

Unit-3

Fabrication Processes: Welding – Classification of welding – Electric Arc Welding- Equipment – Consumables – processes – Gas Welding – Equipment – Processes – Resistance welding – Types of Resistance welding – Soldering & Brazing – Adhesive bonding – Welding Inspection – Defects, Causes & Remedies.

Unit-4

Nonconventional Methods of Manufacturing: Introduction – Need –classification –Electro-Discharge Machining – Electro-Chemical Machining – Laser Beam Machining – Abrasive Jet Machining –Water jet Cutting Ultrasonic Machining –– High Velocity Forming of Metals – Explosive Fabrication – Hydro forming – Electro-hydraulic Forming – Magnetic pulse Forming – Electron Beam Machining.

PRACTICE

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Preparation of Green sand mould using wooden pattern	Green Sand & Wooden pattern	Hands on Experience
2.	Determination of Grain Fineness Number	Sand, Sieving Machine	Hands on Experience
3.	Determination of Permeability Number	Permeability machine	Hands on Experience
4.	Determination of Compressive and Shear strength of moulding sand	Shear strength machine	Hands on Experience
5	Demonstration of pouring the Non Ferrous Metal by using Crucible Tilting Furnace	Crucible Tilting Furnace	Creative Thinking
6	Arc welding – Straight line Beads and Butt joint	Welding Tools	Hands on experience
7	Hands on training on basic welding joints-L Joint & T-Joint	Welding tools	Thinking Skill
8	Preparations of welding models like 3-like main gate, Stair case etc.	Welding tools	Creative Thinking & team work

TEXT BOOKS

1. S.Gowri, P.Hariharan, A.Suresh Babu "Manufacturing Technology-I", Pearson Education, 2008
2. P.C.SHARMA, "A Text book of Production Technology", S.Chand and Co., Ltd., 1999.
3. S. Kalpakjian, "Manufacturing Processes for Engineering Materials", Fifth edition. Pearson Education, 2009.
4. Ghosh and Mallick A. K., "Manufacturing Science". Affiliated East-West Press Pvt. Ltd., 2010.

REFERENCE BOOKS

1. R.K.Rajput, "Manufacturing Technology", Laxmi Publications Ltd., New Delhi,2007
2. D.K.Sngh, "Fundamentals of Manufacturing Engineering", Ane Books India, New Delhi, 2008
3. R.S.Parmar, "Welding Processes and Technology", Khanna Publishers, New Delhi, 2003.

JOURNALS/MAGAZINES:

1. International Journal of Machine Tools and Manufacture
2. International Journal of Scientific & Engineering Research

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/browse/physical-science-and-engineering/mechanical-engineering
2. https://www.my-mooc.com/en/categorie/mechanical-engineering
3. https://nptel.ac.in/cours

Course Title	Mechanics of Materials				Course Type		Hard Core	
Course Code	B20ER0304	Credits	4		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**4**	**5**	**5**	**39**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

This course of Mechanics of Solids deals with behavior of bodies subjected to various types of loadings. This course explores the topic of solid objects subjected to stress and strain. The methods taught in the course are used to predict the response of engineering structures to various types of loading, and to analyze the vulnerability of these structures to various failure modes. This course introduces students to the fundamental principles and methods of structural mechanics. Topics covered include: static equilibrium, force resultants, support conditions, analysis of determinate planar structures , stresses and strains in structural elements, states

of stress (shear, bending, torsion), statically indeterminate systems, displacements and deformations, elastic stability, and approximate methods. Design exercises are used to encourage creativity in students.

COURSE OBJECTIVES

1. To develop the basic knowledge on different stress & strain in materials under various loading conditions
2. To incorporate the concept of Transformation of Stress and Strain and to understand the concepts of torsion and its application to design of shafts
3. To incorporate the concept of Shear Force, Bending Moment Diagram, Bending stress and deflection of beams
4. To understand the concepts of column loading and its effect due to buckling, stress & strain in cylinders and Static failure criteria

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Explain concept of stress & strain in materials under various loading conditions.	1,2	1,2
CO2	Compute various types of stresses and strains, elastic constants for given load conditions.	1,2, 9, 10	1,2
CO3	Plot Shear Force, Bending Moment Diagrams for various types of beams under different loading and boundary conditions and Mohr's Circle for given type of loading.	1,2, 9, 10	1,2
CO4	Derive general torsion and bending equations and compute torque, bending moment, shear stress, bending stress, deflection of beams for different loads and boundary conditions.	1,2,9,10	1,2
CO5	Explain the behavior of columns under different loads and end conditions and compute crippling load.	1,2	1,2
CO6	Apply Lame's Theorem to predict the failure of cylinders.	1,2	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√			
CO4			√			
CO5		√				
CO6			√			

COURSE ARTICULATION MATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1											3	3	
CO2	3	2							3	3			3	3	
CO3	3	1							3	3			3	3	
CO4	3	3							3	3			3	3	
CO5	3	3							3	3			3	3	
CO6	3	3											3	3	
Average	3	2.2							3	3			3	3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Simple Stress and Strain: Types of Loading, Axial, Shear, Concept of stress, Strain, Stress-strain diagram, Hooke's law, Young's modulus, Application to the Analysis and Design of Simple Structures, deformation in statically determinate problems, Elastic Constants, complementary shear stress, lateral strain and Poisson's ratio, Thermal Stresses.

Unit-2

Transformation of Stress and Strain: Transformation of plane stress, Principal Stresses, Maximum Shearing Stress, Mohr's Circle for Plane Stress.

Torsion: Torsion in Solid & Hollow Circular Shafts, Torque and Power Transmitted by Solid and Hollow Shafts, Strength of Shafts.

Unit-3

Analysis of Beams: Shear force and bending moment diagrams of cantilevers, simply supported beams under concentrated, uniformly loaded, varying loads and externally applied moments with and without overhangs. Stresses in beams: beam of uniform strength, bending equation, Beam Deflection: slope and deflection at a section for cantilevers under concentrated and uniformly distributed loads using MaCaulay's method.

Unit-4

Columns: Classification of columns, end connections, Euler's formulae and Rankine Gordon equations.

Cylinders: Thin and thick cylinders, Lame's Theorem, compound cylinders, Static and Dynamic failure criteria.

PRACTICE

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Identification of Microstructure	Polishing Machine and Metallurgical Microscope	Material Identification
2	Tensile Test	Universal Testing Machine	Hands on Experience
3.	Compression Test	Universal Testing Machine	Hands on Experience
4.	Bending Test	Universal Testing Machine	Hands on Experience
5.	Shear Test	Universal Testing Machine	*Hands on Experience*
6.	Torsional Test	Torsion Testing Machine	Hands on Experience
7.	Hardness Test	Hardness testing machine	Hands on Experience
8.	Impact Test	Pendulum type impact testing machine	Hands on Experience
9	Wear Test	Pin on Disc	Hands on Experience

TEXT BOOKS

1. F.P.Beer & Russell Johnstan, John T Dewolf, David F Mazurek "Mechanics of Materials", in S.I. Units, TATA Mc Graw Hill, New York, 6th Edition, 2012.
2. S. H. Crandall et al., "An Introduction to Mechanics of Solids (In SI Units)", McGraw-Hill, Third Edition, 2017.
3. Singer, F.L. Strength of Materials, 3rd Edition, Harper and Row Publishers, New York, 1980.

REFERENCE BOOKS

1. R.C.Hibbeler,"Mechanics of Materials", Printice Hall. Pearson Edu., 2005
2. S.S.Bhavikatti,"Strength of Materials", Vikas publications House -1 Pvt. Ltd., 2nd Edition, 2006.
3. Timoshenko.S.P "Strength of Materials", Part1, D.Van Nostrand Company, Inc. Newyork
4. R K Bansal, "Engineering Mechanics and Strength of Materials", Laxmi Publications-New Delhi, 2004.

JOURNALS/MAGAZINES

1. International Journal of Mechanics of solids

2. International Journal of Strength of Materials

SWAYAM/NPTEL/MOOCs:

1. https://www.udemy.com/course/basic-concepts-of-mechanics-of-materials-for-machine-design/
2. https://nptel.ac.in/courses/105/106/105106172/
3. https://www.coursera.org/learn/mechanics-1

Course Title	Communication Skills				Course Type		FC	
Course Code	B20AH0301	Credits	2		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**2**	**2**	**2**	**26**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course is aimed to develop basic communication skills in English in the learners, to prioritize listening and reading skills among learners, to simplify writing skills needed for academic as well as workplace context, to examine that the learners use the electronic media such as internet and supplement the learning materials used in the classroom.

COURSE OBJECTIVES

The objectives of this course are to:

1. Develop basic communication skills in English.
2. Emphasize on the development of speaking skills amongst learners of Engineering and Technology
3. Impart the knowledge about use of electronic media such as internet and supplement the learning materials used in the classroom.
4. Inculcate the habit of reading and writing leading to effective and efficient communication.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate speaking ability with clarity, confidence and comprehension and communicate with one or many listeners using appropriate communicative strategies (SpeakingSkills).	9, 10	
CO2	Build inferences from the text.	10	
CO3	Make use of accurate writing skills using different components of academic writing.	9, 10	
CO4	Develop the ability to write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic	9, 10	
CO5	Make use of reading different genres of texts adopting various reading strategies (Reading Skills).	10	
CO6	Apply appropriate vocabulary and grammar in written and spoken context.	9, 10	

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√			

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO4						√
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1									2	3					
CO2										3					
CO3									1	3					
CO4									2	3					
CO5										2					
CO6									2	2					
Average									1.8	2.7					

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

Unit – 1

Functional English: Grammar: Prepositions; Modal Auxiliaries, Reading Comprehension, Active and passive voice, Giving Instructions.

Unit – 2

Interpersonal Skills: Grammar: Tenses; Wh-questions, Compound words; Phrasal verbs, Recommendations

Unit – 3

Multitasking Skills Grammar: Conditional Sentences, Homonyms; homophones, Subject-verb agreement.

Unit – 4

Communication Skills Grammar: Direct and indirect speech, Interpreting visual materials (line graphs, pie charts etc.), Single word substitutes.

TEXT BOOKS

1. Green, David, "Contemporary English Grammar Structures and Composition", New Delhi: MacMillan Publishers, 20l0.
2. Thorpe, Edgar and Showick Thorpe, "Basic Vocabulary", Pearson Education India, 20l2.
3. Leech, Geoffrey and Jan Svartvik, "A Communicative Grammar of English", Longman, 2003.

REFERENCE BOOKS

1. Murphy, Raymond, "Murphy's English Grammar with CD", Cambridge University Press, 2004.
2. Rizvi, M. Ashraf, "Effective Technical Communication", Tata McGraw-Hill, New Delhi, 2005.
3. Riordan, Daniel, "Technical Communication", Cengage Publications, New Delhi, 2011.
4. Sen, "Communication and Language Skills", Cambridge University Press, 2015.

Course Title	**Indian Constitution and Professional Ethics**				**Course Type**		**FC**	
Course Code	**B20LS0301**	**Credits**	**2**		**Class**		**III Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**2**	**2**	**2**	**26**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The Constitution of India lays down in defining fundamental political principles, establishes the structure,

procedures, powers and duties of government institutions and sets out fundamental rights, directive principles and duties of citizen. It helps to know and understand the human rights and human values. It also helps to know the meaning of ethics and need of ethics in personal and professional life.

COURSE OBJECTIVES

The objectives of this course are to:

1. Explain basic knowledge required to understand Constitution of India.
2. Describe the Fundamental Rights, Duties and other Rights.
3. Discuss different types of ethics.
4. Explore ethical standards followed by different companies.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Analyze the Fundamental Rights, Duties and other Rights protected under Indian Constitution.	6,7,8,9, 12	
CO2	Demonstrate the practicality of Constitution perspective and make them to face the world as a bonafide citizen.	8 ,12	
CO3	Illustrate the professional ethics and human values.	6,8,12	
CO4	Summarize ethical standards followed by different companies.	7,8,12	
CO5	Demonstrate the Knowledge of Ethics to protect environment as an Engineer	6, 7, 8, 12	
C06	Apply the principles of Ethics as an employee employer in the professional life	6, 8, 9, 12	

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1				√		
CO2		√				
CO3			√			
CO4			√			
CO5		√				
C06		√				

COURSE ARTICULATION MATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2	2	3	2			1			
CO2								3				1			
CO3						2		3				1			
CO4							2	3				1			
CO5						2	2	3				1			
C06						2		3	1			1			
Average						2	2	3	1.5			1			

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

Unit – 1

Indian constitution: Sailent features, fundamental rights and duties (Directive principle and state policy), Legislature (Loka Sabha & Rajya Sabha), Executive (President& Governor) and Judiciary (Supreme court & high court), Composition and function of parliament, Council of ministers, prime minister, Speaker, Passing of bills.

Unit – 2

Human Rights: Nature and Scope of human rights, Universal protection of human rights (UDHR),Regional protection of human rights, National level protection of human rights, Human rights and vulnerable groups (children, women & old-age).

Human Values: Truth, Honesty, Loyalty, Love, Peace with examples, Difference between ethics, beliefs and morals.

Unit – 3

Ethics: Meaning, Definition, Evolution, Need of ethics, Aristotlean Ethics, Utilitarianism, Katianism, human values(Good conduct, respect for elders), ethical human conduct (Gender equality), Professional Ethics, Personal Ethics and Business Ethics, Ethical Standards, Duties of Employers and Employees.

Unit – 4

Engineering Ethics: Definition Scope and needs, Ethics in Consumer Protection, Due Care theory, Environmental Ethics, Ethical Code of Conduct in ethics. Best Ethical Companies in India and Abroad; Corporate Social Responsibilities, Code of Conduct and Ethical Excellence

TEXT BOOKS

1. Kapoor, S.K., "Human rights under International Law and Indian Law", Prentice Hall of India, New Delhi, 2002.
2. Basu, D.D., "Indian Constitution", Oxford University Press, New Delhi, 2002.
3. Chakraborty, S.K., "Values and ethics for Organizations and Theory Practice", Oxford University Press, New Delhi, 2001.

REFERENCES BOOKS

1. Meron Theodor, "Human Rights and International Law Legal Policy Issues", Vol. 1 and 2, Oxford University, Press, New Delhi, 2000.
2. M V Pylee, "An Introduction to Constitution of India", S Chand & Company, 5th Edition.
3. Durga Das Basu, "Introduction to constitution of India", LexisNexis, 23rd Edition.

Self-Learning Exercises: Abuse of Technologies: Hacking and other crimes, addiction to mobile phone usage, video games and social networking websites

REVA UNIVERSITY
Bengaluru, India

ರುಕ್ಮಿಣಿ ಜ್ಞಾನವನ, ಕಟ್ಟಿಗೇನಹಳ್ಳಿ, ಯಲಹಂಕ, ಬೆಂಗಳೂರು – 560064

ಕನ್ನಡಿಗರಿಗೆ ಇಂಜಿನಿಯರಿಂಗ್ ಪ್ರಥಮ ಪದವಿ ಪಠ್ಯ

ಪರಿವಿಡಿ

ಘಟಕ – 1 : **ಕವಿತೆಗಳು**

1. ಬೆಳಗು – ದ ರಾ ಬೇಂದ್ರೆ
2. ಕಲ್ಕಿ – ಕುವೆಂಪು

ಘಟಕ – 2 : **ಕಥೆಗಳು**

3. ಗಾಂಧಿ – ಬೆಸಗರಹಳ್ಳಿ ರಾಮಣ್ಣ
4. ಸೆರೆ – ಯಶವಂತ ಚಿತ್ತಾಲ

ಘಟಕ – 3 : **ವಿಜ್ಞಾನ ಲೇಖನಗಳು**

5. ಆನೆಹಳ್ಳದಲ್ಲಿ ಹುಡುಗಿಯರು – ಬಿ ಜಿ ಎಲ್ ಸ್ವಾಮಿ
6. ವೃತ್ತಿಶಿಕ್ಷಣದಲ್ಲಿ ಕನ್ನಡ ಮಾಧ್ಯಮ – ಎಸ್ ಸುಂದರ್

ಘಟಕ – 4 : ಪರಿಸರ ಲೇಖನಗಳು

7. ಚೀಂಕ್ರ ಮೇಸ್ತ್ರಿ ಮತ್ತು ಅರಿಸ್ಟಾಟಲ್ – ಕೆ ಪಿ ಪೂರ್ಣಚಂದ್ರ ತೇಜಸ್ವಿ
8. ಗುಬ್ಬಚ್ಚಿಯ ಗೂಡು – ಪಿ ಲಂಕೇಶ್

- ಬಿ ಎಂ ಎಸ್ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು ಕನ್ನಡಿಗರಿಗೆ '**ಕನ್ನಡ ಕಲಿ**' ಪಠ್ಯ ಪುಸ್ತಕ
- ಕರ್ನಾಟಕ ತಾಂತ್ರಿಕ ಶಿಕ್ಷಣ ವಿಭಾಗ ಕನ್ನಡಿಗರಿಗೆ **ಸಾಹಿತ್ಯ ಸಿಂಚನ**' ಪಠ್ಯ ಪುಸ್ತಕ
- ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ ಕನ್ನಡಿಗರಿಗೆ '**ಬಳಕೆ ಕನ್ನಡ**' ಪಠ್ಯ ಪುಸ್ತಕ

ಹಲವಾರು ಪಠ್ಯಪುಸ್ತಕಗಳು ಇಂಜಿನಿಯರಿಂಗ್ ವಿಭಾಗದಲ್ಲಿ ಕನ್ನಡ ಬೋಧನೆಗೆ ಬಳಕೆಯಲ್ಲಿದ್ದು ಜೊತೆಗೆ ಬಿಎಡ್ ಕನ್ನಡ ಕಲಿಕೆಯ ಪಠ್ಯಪುಸ್ತಕಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ರೇವಾ ವಿಶ್ವವಿದ್ಯಾಲಯದ ತಾಂತ್ರಿಕ ವಿಭಾಗದ ಕನ್ನಡಿಗರು ಮತ್ತು ಕನ್ನಡೇತರ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಇಷ್ಟವಾಗುವ ಮತ್ತು ಪ್ರಯೋಜನಕಾರಿಯಾಗುವ ಪಠ್ಯ ಪುಸ್ತಕವನ್ನು ತರಗತಿಗಳು ಪ್ರಾರಂಭವಾಗುವುದರ ಒಳಗೆ ಸಿದ್ಧಪಡಿಸಲಾಗುವುದು.

REVA UNIVERSITY
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ರುಕ್ಮಿಣಿ ಜ್ಞಾನವನ, ಕಟ್ಟಿಗೇನಹಳ್ಳಿ, ಯಲಹಂಕ, ಬೆಂಗಳೂರು – 560064

ಕನ್ನಡೇತರರಿಗೆ ಇಂಜಿನಿಯರಿಂಗ್ ಪ್ರಥಮ ಪದವಿ ಪಠ್ಯ

ಭಾಷಾ ಕೌಶಲ್ಯಗಳು

ಘಟಕ – 1

1. ಆಲಿಸುವುದು

- ಆಲಿಸುವ ಕೌಶಲ್ಯ
- ಆಲಿಸುವಿಕೆಯಲ್ಲಿನ ದೋಷಗಳು
- ಉತ್ತಮ ಆಲಿಸುವಿಕೆ

ಘಟಕ – 2

2. ಮಾತನಾಡುವುದು

- ಸಂಭಾಷಣೆ
- ವ್ಯವಹಾರಿಕ ಸಂಭಾಷಣೆ
- ದೋಷಗಳು ಮತ್ತು ಪರಿಹಾರಗಳು

ಘಟಕ – 3

3. ಓದುವುದು

- ಓದು ಕಲಿಸುವಾಗ ಗಮನಿಸಬೇಕಾದ ಅಂಶಗಳು
- ಧ್ವನ್ಯಾಂಗಗಳ ಪರಿಚಯ
- ಓದಿನ ವಿಧಗಳು

ಘಟಕ – 4

4. ಬರೆಯುವುದು

- ವರ್ಣಮಾಲೆಯ ಸ್ವರೂಪ
- ಕಾಗುಣಿತ ಸ್ವರೂಪ
- ಕನ್ನಡ ಸಂಖ್ಯೆಗಳು

- ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ ಕನ್ನಡೇತರರಿಗೆ **'ಬಳಕೆ ಕನ್ನಡ'** ಪಠ್ಯ ಪುಸ್ತಕ
- ಬಿ ಎಂ ಎಸ್ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು ಕನ್ನಡೇತರರಿಗೆ **'ಕನ್ನಡ ಮನಸ್ಸು'** ಪಠ್ಯ ಪುಸ್ತಕ
- ಕರ್ನಾಟಕ ತಾಂತ್ರಿಕ ಶಿಕ್ಷಣ ವಿಭಾಗ ಇವರು **'ಬಳಕೆ ಕನ್ನಡ'** ಪಠ್ಯ ಪುಸ್ತಕ ತಂದಿದ್ದಾರೆ.

ಹಲವಾರು ಪಠ್ಯಪುಸ್ತಕಗಳು ಇಂಜಿನಿಯರಿಂಗ್ ವಿಭಾಗದಲ್ಲಿ ಕನ್ನಡ ಬೋಧನೆಗೆ ಬಳಕೆಯಲ್ಲಿದ್ದು ಜೊತೆಗೆ ಬಿಎಡ್ ಕನ್ನಡ ಕಲಿಕೆಯ ಪಠ್ಯಪುಸ್ತಕಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ರೇವಾ ವಿಶ್ವವಿದ್ಯಾಲಯದ ತಾಂತ್ರಿಕ ವಿಭಾಗದ ಕನ್ನಡಿಗರು ಮತ್ತು ಕನ್ನಡೇತರ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಇಷ್ಟವಾಗುವ ಮತ್ತು ಪ್ರಯೋಜನಕಾರಿಯಾಗುವ ಪಠ್ಯ ಪುಸ್ತಕವನ್ನು ತರಗತಿಗಳು ಪ್ರಾರಂಭವಾಗುವುದರ ಒಳಗೆ ಸಿದ್ಧಪಡಿಸಲಾಗುವುದು.

4TH Semester

Course Title	Probability and Sampling Theory				Course Type		FC	
Course Code	B20AS0403	Credits	3		Class		IV semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**-**	**50 %**	**50 %**

COURSE OVERVIEW

Axiomatic probability theory, independence, conditional probability. Discrete and continuous random variables, special distributions of importance to Mechanical Engineering. Expectation simulation of random variables and Curve fitting, basic statistical inference, parameter estimation, hypothesis testing, and linear regression and correlation. Introduction to stochastic processes and Sampling theory.

COURSE OBJECTIVES

Student will be able to learn,

1. The concept of curve fitting and few statistical methods.
2. Fundamentals of probability- Random variables.
3. Joint probability and regarding stochastic process.
4. Concept of test of hypothesis and able to apply in the various fields of Mechanical engineering.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Approximate a linear and non-linear equation to the given data by the method of least squares.	1,2	1
CO2	Apply the concept of correlation and regression lines for distinct civil engineering problems.	1,2	1
CO3	Define concepts of probability space, random variable, discrete & continuous distribution and use to solve various Mechanical engineering problems	1,2,3	1
C04	Calculate Joint probabilities and derive the marginal and conditional distributions of bivariate random variables.	1,2	1
CO5	Define and use stochastic processes and Markov chains in discrete and continuous time.	1,2	1
C06	Apply sampling theory concepts to solve various Mechanical engineering problems.	1,2	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember(L1)	Understand(L2)	Apply(L3)	Analyze(L4)	Evaluate(L5)	Create(L6)
CO1	√	√	√		√	
CO2	√	√	√		√	
CO3	√	√	√		√	
CO4	√	√	√		√	
CO5	√	√	√		√	
CO6	√	√	√		√	

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO1	3	2											2		
CO2	3	2											2		
CO3	3	2	1										3		
CO4	3	2											2		
CO5	3	2											3		
CO6	3	2											2		
Average	3	2	1										2.3		

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit -1

Curve Fitting: Curve fitting by the method of least squares and fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$, $y = ae^{bx}$ and $y = ax^b$

Statistical Methods: Measures of central tendency and dispersion. Correlation-Karl Pearson's coefficient of correlation-problems. Regression analysis- lines of regression (without proof) –problems.

Unit - 2

Probability Theory: Recap of Probability theory (definition, addition theorem, multiplication theorem and conditional probability and Baye's theorem).

Probability Distributions: Random variables (discrete and continuous), probability mass/density functions, mean, variance and moments. Binomial distribution, Poisson distribution. Exponential and normal distributions, problems.

Unit - 3

Joint Probability Distribution: Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.

Stochastic Process: Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-simple problems.

Unit - 4

Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

TEXT BOOKS

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 48th edition.

2. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 1stedition.

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 13th edition.

2. R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 4th edition.

Course Title	**Mechanical Measurements and Metrology**				**Course Type**		**Hard Core**	
Course Code	**B20ER0401**	**Credits**	**3**		**Class**		**IV Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**4**	**4**	**26**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Metrology is the science of pure measurement. It is concerned with the establishment, reproduction, conservation and transfer of units of measurements and their standards. It's also concerned with the methods, execution and estimation of accuracy of measurements, the measuring instruments and the inspectors. Basic applications include measurement of length, diameter, taper, flatness, and squareness. Etc. Further the course intends to introduce the technological and engineering concepts and study the applications of measuring quantities like force, torque, pressure, temperature, strain.

COURSE OBJECTIVES

1. Understand metrology, its advancements & measuring instruments, acquire knowledge on different standards of length, calibration of End Bars, linear and angular measurements.
2. To introduce the fundamental concepts & derive the relations for the design of gauges, types of gauges, concepts involving comparators, angular measurements.
3. To gain knowledge about various aspects of pressure, speed and surface roughness measurement.
4. To explore the various aspects regarding the force, torque, strain & temperature measurement.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Outline the objectives of metrology, methods of measurement, standards of measurement and describe slip gauges, manufacturing of slip gauges & building of slip gauge blocks for calibration.	1, 9, 10	1
CO2	Describe the need of limit system and working of different types of comparators.	1	1
CO3	Enumerate the pressure, speed and surface roughness measurement	1	1
CO4	Elaborate the concept of measuring force, torque, temperature and strain measurement.	1	1
CO5	Measure the depth and thickness of the given gear tooth using gear tooth Vernier caliper	1,2, 9, 10	2
CO6	Demonstrate the measurement of cutting forces, thread components, angular components	1, 2, 9, 10	2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3		√				
CO4			√			
CO5		√				
CO6		√				

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3								3	3			3	2	
CO2	3												3	2	
CO3	3												3	2	
CO4	2												3	2	
C05	1	1							3	3			2	3	
C06	1	1							3	3			2	3	

Average	2.2	1							3	3			2.7	2.3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Basic of Metrology, Linear and Angular Measurement: Objectives of metrology, role of standards, standards of length- International prototype meter, Imperial standard yard, wave length standard, subdivision of standards, line & end standard, calibration of end bars-numerical, Slip gauges, Wringing phenomenon, Numerical on building of slip gauges, Vernier bevel protractor, Angle gauges, Sine principle, Sine bar & Sine Centre.

Unit-2

Limit Gauges and Comparators: Need of limit system, Tolerance, Specification of tolerance in assembly, Accumulation tolerance & compound tolerance, principle of interchangeability & selective assembly, concept of limit of size & tolerance, Concept of fits, types of fits, shaft basis & hole basis system, geometric tolerance, tolerance grade, design of GO and NO GO gauges using Taylor's principle. Numerical on Limits, Fits and Tolerances. Comparators-types and characteristics Johanson Mikrokator, Sigma comparator, Principle of optical comparator, Zeiss ultra-optimeter, Solex pneumatic comparator, LVDT

Unit-3

Measurement of Pressure, Speed and Surface Roughness: Pressure Measurements: principle, use of elastic members in pressure measurement, Bridgeman gauge, McLeod gauge, Pirani gauge. Speed Measurement: Mechanical counters, contact and non-contact type measurement. Surface Roughness: Introduction, modes of defining surface texture, surface roughness evaluation CLA, RMS, Rmax and Rz, surface texture symbols and specifications, profilometer and Tomlinson surface meter.

Unit-4

Measurement of Force, Torque, Temperature and Strain Force Measurement: Analytical balance, unequal arm balance, proving ring. **Torque Measurement:** Prony brake and hydraulic dynamometer, **Temperature Measurement:** Resistance thermometer, thermocouple, law of thermocouple, materials used for construction, optical pyrometer and radiation pyrometer. **Strain Measurement**: Mechanical and optical strain gauge, electrical strain gauge: Bonded and unbounded resistance strain gauges, strain gauge backing and bonding materials, preparation & mounting of strain gauges.

PRACTICE

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Calibration of Micrometer using slip gauges	Micrometer, slip gauges	Hands on experience
2.	Calibration of LVDT	LVDT, Micrometer	Hands on experience
3	Measurement of taper angle using Sine bar, sine centre and Roller set method.	Sine bar, sine centre and Tapered specimen, slip gauges, rollers	Hands on experience
4	Measurement of effective diameter of the given screw thread by two wire / three wire method	Screw thread, wire, Bench micrometer	Hands on experience
5	Measurement of flatness by using Autocollimator	Autocollimator, Reflector, surface plate.	Hands on experience
6	Measurement of gear tooth thickness using gear tooth vernier	Gear tooth vernier caliper, spur gear	Hands on experience
7	Measurement of cutting forces using lathe tool dynamometer	Lathe machine with dynamometer	Hands on experience

8	Measurement of cutting forces using drill tool dynamometer	Drilling machine with dynamometer	Hands on experience

TEXT BOOKS

1. R.K. Jain, Engineering Metrology, Khanna Publishers, 1994.
2. I.C.Gupta, Engineering Metrology Dhanpath Rai Publications.

REFERENCE BOOKS

1. Beckwith Marangoni and Lienhard, Mechanical Measurements, Pearson Education, 6th Ed., 2006.
2. Anand K. Bewoor & Vinay A. Kulkarni Metrology & Measurement, Tata McGraw.
3. N.V Raghavendra & L. Krishnamurthy, Engineering Metrology and Measurements, Oxford University Press.

JOURNALS/MAGAZINES

1. https://www.journals.elsevier.com/measurement
2. https://iopscience.iop.org/journal/0957-0233

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112/106/112106179/
2. https://nptel.ac.in/courses/112/106/112106139/

Course Title	**Machining Process**				**Course Type**		**Hard Core**	
Course Code	**B20ER0402**	**Credits**	**4**		**Class**		**IV Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**4**	**5**	**5**	**39**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

This course would encompass a comprehensive study of metal cutting and machine tools. The students will go through the fundamentals and principles of metal cutting to practical applications through multiple labs using lathes, milling machines, grinding machines, and drill bits, Computer Numerical Control etc. Tool geometry, chip formation, cutting force calculations and measurement, tool wear and other aspects will be given due attention.

COURSE OBJECTIVES

1. To familiarize the student with tool nomenclature and cutting forces
2. To incorporate the concepts of various machining operations to prepare a model using lathe as per dimensions
3. To give exposure of various machines used for manufacturing of metal components.
4. To incorporate the suitable super finishing process to produce the intricate components and CNC technology
5. To help students acquire knowledge about theory of metal cutting, mechanism of machining and analyze process parameters influence.
6. To explain and demonstrate the different instruments for linear and angular measurements.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Analyze forces acting on the cutting tool in orthogonal and oblique cutting and various process parameters to improve the cutting tool life	1,2, 9, 10	1,2
CO2	Describe various machining process used for machining of components.	1, 9, 10	1,2
CO3	Explain various machines used for manufacturing of metal components	1,2,3	1,2
CO4	Identify the cutting tools required for different machining processes.	1,2,3	1,2

CO5	Demonstrate the cutting forces induced during the metal cutting operations and understand the influence of process parameters.	1,2,3, 9, 10	1,2
CO6	Compare the working of conventional and CNC machine.	1, 2	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√			
CO4		√				
CO5				√		
CO6			√			

COURSE ARTICULATION MATRIX

CO/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2							3	3			3	3	
CO2	2								3	3			2	2	
CO3	2												3	2	
CO4	3	1											3	1	
CO5	3	1							3	3			3	2	
CO6	3	1							3	3			3	2	
Average	2.7	1.3							3	3			2.8	2.0	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Theory of Metal Cutting: Introduction, Geometry of a single point cutting tool, Chip formation and types of chips, Orthogonal and oblique cutting, Merchant circle diagram for cutting forces, Shear angle in terms of chip thickness ratio and rake angle, friction, Numerical on shear angle, Machining variables, Factors affecting cutting tool life, Types of tool wear, Taylor's tool life equation, Numerical on Taylor's tool life equation, Cutting tool materials of common use and their characteristics, Functions of cutting fluids, Types of cutting fluids, Heat generation in metal cutting and factors affecting heat generation.

Unit-2

Lathe: Working principle and specifications of lathe, center lathe and its components, lathe operations, Constructional features of turret and capstan lathe.

Drilling Machine-Principle of working, Classification, construction and working of Bench and Radial drilling machines, drilling operations, drill bit nomenclature, simple numerical on machining time.

Shaping Machine: Introduction, types, construction and operations of horizontal shaper.

Unit-3

Milling: Principle of working, Classification of Milling machines, construction and working of Horizontal and vertical milling machines. Milling operations, methods of indexing, simple and compound indexing, numerical on simple indexing.

Grinding: Working principle, constructional features of Cylindrical, Center less and Surface grinding machines, Types of abrasives, bonding process, marking of grinding wheels. Dressing and truing of grinding wheels.

Unit-4

Lapping: Principle of Lapping, Lapping methods, Advantages and limitations of lapping.

Honing: Principle of honing, Types of honing machines, Advantages, limitations and applications of honing.

Broaching: Principle of working – Details of a commonly used broach, construction and working of a horizontal broaching machine, Advantages, limitations and applications.

CNC Machines: Overview, types, construction, tool and work holding devices, feedback devices, part programming, examples.

PRACTICE

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Introduction to Lathe machine and to establish the cutting speed, feed, depth of cut.	Lathe Machine	Hands on Experience
2.	Preparation of Facing and Turning model	Lathe Machine	Hands on Experience
3.	Establishing Taper turning and Step turning models	Lathe Machine	Hands on Experience
4.	Preparing Thread cutting model by defining the cutting speed.	Lathe Machine	Hands on Experience
5	Producing cylindrical hole in the given model	Lathe Machine	Hands on Experience
6	Gear Cutting using milling machine	Milling Machine	Hands on Experience
7	Cutting V-Groove/Dovetail/Rectangular shapes by using Shaping Machine	Shaping machine	Hands on Experience
9	Demo on eccentric turning.	Lathe Machine	Knowledge

TEXT BOOKS

1. R.K Jain, “Production Technology”, Khanna Publications, 2003.
2. P N Rao, “Manufacturing Technology”, McGraw-Hill Education, (Volume II), 2018
3. Kalpakjian, Serope, “Manufacturing Engineering and Technology”, Addison –103esley publishing co., New York

REFERENCE BOOKS

1. Hajra Choudhury, “Workshop Technology Vol-II”, Media Promoters & Publishers Pvt. Ltd. 2004
2. Amitabh Ghosh and Mallik, “Manufacturing Science”, affiliated East West Press, 2003
3. G.C Sen & Bhattacharya, “Principle of Machine Tools”, Tata McGraw hill, New Delhi.

JOURNALS/MAGAZINES

1. International Journal of Machine Tools and Manufacture
2. Journal of Manufacturing Processes

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/browse/physical-science-and-engineering/mechanical-engineering
2. https://onlinecourses.nptel.ac.in/noc21_me04/preview

Course Title	Kinematics and Dynamics of Machines				Course Type		Hard Core	
Course Code	B20ER0403	Credits	4		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**4**	**5**	**5**	**36**	**24**	**50 %**	**50 %**

COURSEOVERVIEW

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

Kinematics and dynamics of Machines is a subject which deals with the basic components of machines and mechanisms .It also deals with the study of the velocity and acceleration of mechanisms, gears and arrangement of gear trains, types of cam and follower. It also gives an insight about the balancing of rotating and reciprocating parts used in IC engines, CNC Machineries etc. It also helps to predict the unbalanced and balanced forces and keep the system in dynamic equilibrium between the moving parts. It also provides the gyroscopic principles on plane disc, aeroplane, ship, 2 and 4 wheelers. It also aims at the study of controlling forces on governors.

COURSE OBJECTIVES

1. To gain the knowledge on mobility of mechanisms, velocity and acceleration of mechanisms.
2. Computation of degree of freedom for different mechanisms and machines.
3. To analyze velocity, acceleration, different tooth forms, mesh and their arrangements.
4. To introduce the concept of gyroscopic effect in aero plane, ship, two wheeler, and four wheeler vehicle.
5. To explain the working principal, mechanism and application of governors.
6. To develop the analytical approach and graphical methods in balancing the unbalanced forces and couples in engine.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Differentiate the different mechanisms and determine, velocity, acceleration and their instantaneous center	1,2, 9, 10	1,2
CO2	Computation of DOF for different mechanisms and structures	1,2, 9, 10	1,2
CO3	Compare the various types of gears and gear train and evaluating their performance	1,2, 9, 10	1,2
CO4	Draw the various cam profile based on the follower motions and followers and their terminologies	1.2,3, 9, 10	1,2
CO5	Analyze the balancing forces and couples polygon of engines, and derive the balancing condition for rotating and reciprocating masses.	1,2, 9, 10	1,2
CO6	Evaluate the performance of governor and Analyze the gyroscopic effect and stability of aeroplane, two wheeler and four wheelers.	1,2, 9, 10	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3		√				
CO4		√		√		
CO5		√		√		
CO6		√		√		

COURSE ARTICULATIONMATRIX

CO/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2							3	3			1	2	
CO2	3	2											1	3	
CO3	3	2							3	3			3	1	
CO4	3	2							3	3			2	1	
CO5	3	2							3	3			1	2	
CO6	3	2							3	3			1	2	

Average	3	2							3	3			1.5	1.8	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Introduction: Links-types, Kinematics pairs-classification, Kinematic Chain ,Constrained Motions-types, Degrees of freedom of planar mechanism, linkage mechanisms, inversions of four bar chain, slider crank chain and double slider crank chain.

Velocity and Acceleration of Mechanism: Velocity of point in mechanism, Relative and Instantaneous Velocities in four bar and slider crank mechanism, Instantaneous center method, Types & location of instantaneous centers for different mechanisms, Kennedy's theorem. Introduction to Acceleration of a point on a link

Unit -2

Gears and Gear Trains: Classification & terminology, law of gearing, tooth forms & comparisons, Systems of gear teeth, Analysis of spur gears, Length of path of contact, contact ratio, interference & under cutting in involute gear teeth, minimum number of teeth on gear and pinion to avoid interference, Gear Trains: Simple, compound, reverted and Epicyclic gear train. **(No derivation and Problems in gears and gear trains)**

Cams and Followers - Classification & Terminology, Cam profile by graphical methods with knife edge and roller follower for uniform velocity, uniform acceleration and retardation, simple harmonic Simple numerical (no offset follower)

Unit 3

Balancing of Rotating Masses: Static and dynamic balancing. Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Balancing of primary force in reciprocating engine, partial balancing of multi cylinder locomotives inline engine and V- engine. Numerical.

Unit 4

Governors: Introduction, principles, Types of governors, Terminology, force analysis of Porter, sensitivity, stability, Hunting, Isochronism, effort and power of governor, controlling force diagram. Numerical. Introduction to speed synchronizer.

Gyroscope: Principles, Gyroscopic Torque, effect of gyroscopic couple on the stability of disc, aero plane, two wheeler and four wheeler.

PRACTICE

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Analysis of 4 bar Mechanism and Slider Mechanism, 2 problems each	Adams	Hands on Experience
2.	Analysis of Cams , Gears and gear Trains	Adams	Hands on Experience
3.	To determine the power, effort, controlling force, sensitiveness of the porter governor	Porter governor experimental setup	Hands on Experience
4.	To determine the magnitude, position of unknown rotating masses using Balancing Machine.	Balancing Machine	Hands on Experience
5	Gyroscope(Demo Only)	Gyroscope	Hands on Experience
6	Analysis of gear trains and gear for a small machine component	Analyzing and suggesting	Thinking

TEXTBOOKS

1. R S Khurmi, "Theory of Machines", Schand Publishing House.

2. S S Rattan, "Theory of Machines", Tata Mc Graw Hill Education Private Limited New Delhi.

REFERENCE BOOKS:

1. VP Singh, "Theory of Machines", Dhanpat Rai Publishing, 2004
2. Joseph E Shigley, "Theory of Machines and Mechanisms", Oxford Higher Education International Version.
3. R K Bansal, "Theory of Machines, Lakshmi Publications Ltd, New Delhi.

JOURNALS/MAGAZINES

1. Mechanism and Machine Theory | journal | sciencedirect.com by elsevier
2. Applied Theories on Machines | List of High Impact Articles | PPts | Journals | Videos (longdom.org)

SWAYAM/NPTEL/MOOCs

1. NPTEL: Mechanical Engineering - Theory Of Mechanisms
2. http://ecoursesonline.iasri.res.in/course/view.php?id=522
3. Adams Tutorial Kit for Mechanical Engineering Courses (mscsoftware.com)

<table>
<tr><td>Course Title</td><td colspan="4">Computer Aided Machine Drawing</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ER0404</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">IV Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Practice</td><td>2</td><td>4</td><td>4</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>5</td><td>5</td><td>12</td><td>48</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

The students of mechanical engineering program are mainly involved in drafting, manufacturing, inspection and planning activities (such as preparing process plans, preparing bill of materials, etc.) in industries. For all such activities, reference document is the drawing of component/assembly to be manufactured. In this context, it is of utmost important to prepare, read and interpret component drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of drafting are also important for the students to make them aware of drafting practices, symbols, codes, norms and standards generally used in industries. Development of sketching ability also strengthens effective engineering communication & presentation. Now a days the market driven economy demands frequent changes in product design to suit the customer needs. With the introduction of computers the task of incorporating frequent changes as per requirement is becoming simpler. This course has been introduced at B.Tech level in order to develop the skills in student so that they can generate various production drawings as required in industry using various CAD software.

COURSE OBJECTIVES

1. To understand drawing and develop the capacity to represent any matter/object and to impart knowledge of machine component and its conversion into 2D drawing.
2. To develop the ability to apply Limits, Fits, and Dimensional Tolerances, as well as Geometric Tolerances to components and assemblies on Engineering Drawings.
3. To create awareness about the Riveted joints and coupling/joints with their empirical relations.
4. To develop an ability to Create Solid Models of machine components.
5. Able to apply these skills to the solution of a variety of practical problems and be able to employ their knowledge to solve more complicated problems.
6. To develop an ability to Create assembly models of simple machine Parts. The student should be prepared to continue the study of computer aided machine drawing through further subjects/projects in further years of engineering.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Visualize and formulate detail drawing of a given object.	1,2,5,10	1,2,1

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO2	Design and sketch the orthographic view of square headed and hexagonal headed bolt and nut assembly as per BIS.	1,2,10	1,2,1
CO3	Design and sketch single and double riveted butt joints as per stated conditions.	1,2,3,10	1,2,1
CO4	Design and sketch details and assembly of cotter joint and knuckle joint	1,2,3,10	1,2,1
CO5	Design and sketch details and assembly of split muff coupling, protected type flanged coupling	1,2,3, 10	1,2,1
CO6	Create 2-D, 3-D models and assemble the parts of mechanical systems by using standard CAD software with manufacturing considerations.	1,2,3,5,10	1,2,1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6						√

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			2					2		1	3	1	1
CO2	3	2	2							2			3	1	1
CO3	3	2	2							2			3	1	1
CO4	3	1	2							2			2	1	1
CO5	3	2	2							3			3	1	1
CO6	3	2	3		3					3		1	3	1	1

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit-1

Introduction to GD&T: Limits, Fits and Tolerances, Rule of G D & T: Datum and its application, Form Tolerances and its applications.

Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine. (Bureau of Indian Standards conventions are to be followed for the drawings).

Unit-2

Fasteners: Orthographic projection of Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly).

Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets).

Unit-3

Joints: Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.

Couplings: Split Muff coupling, protected type flanged coupling.

Unit-4

Assembly Drawings: Machine Vice, Plumber Block, Connecting rod, Tailstock. (Preparation of Bill of materials and tolerance data sheet.)

PRACTICE

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Apply GD & T principles on simple machine parts	GD&T, Machine parts	Hands on Experience
2.	Draw orthographic projection of machine components	Drawing tools and CAD Software	Hands on Experience
3.	Draw orthographic projection of Bolts (Hexagonal Head)	Drawing tools and CAD Software	Hands on Experience
4.	Orthographic projection of Bolts (Square Head)	Drawing tools and CAD Software	Hands on Experience
5	Draw orthographic projection of riveted joints	Drawing tools and CAD Software	Creative Thinking
6	Draw orthographic projection of joints for connecting two shafts like Cotter or Knuckle Joint, couplings.	Drawing tools and CAD Software	Creative Thinking
7	Assemble the parts of Machine Vice and Draw the following orthographic views. a) Front view with full section b) Top View	Drawing tools and CAD Software	Hands on experience & Creative Thinking
8	Assemble the parts of PLUMMER BLOCK and Draw the following orthographic views. a) Front view with full section b) Top View	Drawing tools and CAD Software	Hands on experience & Creative Thinking
9	Assemble the parts of CONNECTING ROD and Draw the following orthographic views. a) Front view with full section b) Top View	Drawing tools and CAD Software	Hands on experience & Creative Thinking
10	Assemble the parts of TAILSTOCK and Draw the following orthographic views. a) Front view with full section b) Top View	Drawing tools and CAD Software	Hands of experience & Creative Thinking

TEXT BOOKS

1. K R Gopalakrishna, “Machine Drawing”, Subhas Stores, 2005.
2. N. D. Bhatt and V.M. Panchal, “Machine Drawing”, Charotar Publishing House, 2014
3. P S Gill, “Machine Drawing”, Kataria & Sons, 2009

REFERENCE BOOKS

1. Ajeet Singh, Machine Drawing Includes AutoCAD, Tata McGraw-hill, 2012.
2. Sham Tickoo , “CAD for engineers and designers”, Dream Tech, 2005.
3. P I Vargheese and K C John, “Machine Drawing”, VIP Publishers, 2011.
4. Dr. Alex Krulikowski, “Fundamentals of Geometric Dimensioning and Tolerancing”, University of Michigan, Third Edition, 2014.

SWAYAM/NPTEL/MOOCs

1. https://www.coursera.org/browse/physical-science-and-engineering/mechanical-engineering
2. https://www.my-mooc.com/en/categorie/mechanical-engineering

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

3. https://nptel.ac.in/cours

Course Title	MATLAB for Mechanical Engineers				Course Type		Hard Core	
Course Code	B20ER0405	Credits	1		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

This Course provides students a practical introduction to MATLAB by going beyond simple explanations of commands and it demonstrates as how to actually program for real-time applications in Mechanical Domain. It is intended to cater to the needs of budding mechanical engineer in advanced computing.

MATLAB integrates mathematical computing, visualization and powerful language to provide flexible environment for technical computing. The open architecture makes it easy to use MATLAB and its companion products to explore data, create algorithms and custom tools that provide early insights and competitive advantages. It is an all-rounder tool for simulations, programming, graphs, and measurement for an engineer.This course covers the analysis of the problems in basic engineering mechanics, strength of materials, theory of machines thermodynamics based applications along with the introduction to basic MATLAB capabilities.

COURSE OBJECTIVES

1. To make the students to understand the basic computation capabilities of MATLAB
2. To understand plotting for various 2D and 3D requirements
3. To make them solve simple problems of engineering mechanics, strength of materials, theory of machines thermodynamics based applications

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Apply MATLAB to create and manipulate different types of arrays.	1,5, 9, 10	1,2
CO2	Apply MATLAB to analyze, represent and plot 2D and 3D graphs.	1,2,5, 9, 10	1,2
CO3	Use MATLAB's built-in capabilities to solve engineering problems involving systems of linear equations and Curve fitting.	1,2,5, 9, 10	1,2
CO4	Develop, test and debug MATLAB programs using modern, structured programming methods, including graphical user interfaces	1,2,3, 5, 9, 10	1,2
CO5	Apply MATLAB to solve real-time problems in the areas of Engineering Mechanics, Strength of materials and thermal based problems.	1,2,3,5, 9, 10	1,2
CO6	Apply MATLAB to solve real-time problems in the areas of stability analysis of four and two wheelers	1,2,3,5, 9, 10	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√			
CO4			√			

CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3				3	3			3	3	
CO2	3	3			3				3	3			3	3	
CO3	3	2			3				3	3			3	3	
CO4	3	1	3		3				3	3			3	3	
CO5	3	2	3		3				3	3			3	3	
CO6	3	1	3		3				3	3			3	3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

PRACTICE

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Introduction to MATLAB: Starting of MATLAB, elementary functions, commands and variables	MATLAB	Hands on Experience
2	Arrays: Creation and Manipulations of array, built in functions for arrays, Reading Data from Files	MATLAB	Hands on Experience
3.	Graphics: Two dimensional and three dimensional plots and formatting of plots.	MATLAB	Hands on Experience
4.	Numerical Analysis: Curve Fitting, Interpolation and Solving Systems of Linear Equations.	MATLAB	Hands on Experience
5.	Programing in MATLAB: Loops and conditional statements	MATLAB	Hands on Experience
6.	Force analysis in flexible elements like cables of cranes	MATLAB	Hands on Experience
7.	Stress analysis in simple bodies subjected to axial loading, shear loading, bending and torsional loading	MATLAB	Hands on Experience
8.	Beam Analysis for SFD and BMD	MATLAB	Hands on Experience
9.	Analysis of Thermal Systems such as Performance of Air Standard Cycles , Gas Power and Vapor Power Cycles	MATLAB	Hands on Experience
10.	Performance analysis of Compressor and Refrigeration Systems	MATLAB	Hands on Experience
11.	Stability analysis of four and two wheelers	MATLAB	Hands on Experience

TEXT BOOKS

1. Peter I. Kattan,"MATLAB for Beginners: A Gentle Approach", Petra Books, 2008.
2. R. V Dukkipati, "MATLAB for Mechanical Engineers", New Age Science Limited, 2009.
3. Manual on "Mechanical Engineers and MATLAB"- Dr.Niranjan H and Mr.Siva.S, School of Mechanical Engineering, REVA University, Bangalore.

REFERENCE BOOKS

1. J. Srinivas and R. V Dukkipati, Solving Engineering Mechanics Problems with MATLAB, New Age International (P) Limited, 2009.
2. Simin Nasseri, "Solving Mechanical Engineering Problems with MATLAB", Linus Learning, 2016.

SWAYAM/NPTEL/MOOCs

1. https://www.udemy.com/course/matlab-basics-for-mechanical-engineers/
2. https://www.coursera.org/courses?query=matlab

Course Title	Management Science				Course Type		HC	
Course Code	B20MGM301	Credits	2		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**2**	**2**	**2**	**26**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The course intends to familiarize students to understand the management principles and applications, which lays a strong foundation for managers and leaders in critical thinking and decisions making process. The course emphasizes on giving an overview of the functional area of management

COURSE OBJECTIVES

1. To help the students gain understanding of the functions and responsibilities of managers.
2. To provide them tools and techniques to be used in the performance of the managerial job.
3. To enable them to analyze and understand the environment of the organization.
4. To help the students to develop cognizance of the importance of management principles.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Make use of Plan organizational structure for a given context in the organization carry out production operations through Work-study.	1-5	2
CO2	Analyze production operations through Work-study.	1-5	3
CO3	Understand the markets, customers and competition better and price the given products Appropriately.	1-5	2
CO4	Summarize the HR function better.	1-5	2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3				√		
CO4			√			

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2										2	1	1	1	
CO2	2	1									2	1	1	1	
CO3	2										2	1	1	1	
CO4	2	1									2	1	1	1	
Average	2	1									2	1	1	1	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

Unit – 1

Introduction to Management and Organization: Concepts of Management and organization- nature, importance and Functions of Management. Systems Approach to Management – Taylor's Scientific Management Theory- Taylor's Principles of Management, Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory – Hertzberg Two Factor Theory of Motivation – Leadership Styles, Social responsibilities of Management. Designing Organizational Structures: Basic concepts related to Organization Depart mentation and Decentralization.

Unit – 2

Operations and Marketing Management: Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production), Work Study –Basic procedure involved in Method Study and Work Measurement – Business Process Reengineering(BPR) Statistical

Quality Control: control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, TQM, Six Sigma, Deming's contribution to quality. Objectives of Inventory control, EOQ, ABC Analysis. Purchase Procedure, Stores Management and Store Records – JIT System, Supply Chain Management, Functions of Marketing, Marketing Mix. And Marketing Strategies based on Product Life Cycle. Channels of distribution.

Unit – 3

Human Resources Management (HRM): Concepts of HRM. HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR. Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development. Placement, Wage and Salary Administration, Promotion. Transfer, Separation, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating – Capability Maturity Model (CMM) Levels – Performance Management System.

Unit – 4

Strategic Management and Contemporary strategic Issues: Mission, Goals, Objectives, Policy, Strategy. Programmes, Elements of Corporate Planning Process, Environmental Scanning. Value Chain Analysis, SWOT Analysis. Steps in Strategy Formulation and implementation, Generic. Strategy alternatives. Bench Marking and Balanced Score and as Contemporary Business Strategies.

TEXT BOOKS

1. Kotler Philip and Keller Kevin Lane, "Marketing Management", Pearson, New York, 15th Edition, 2012.
2. Koontz and Weihrich, "Essentials of management", McGraw Hill, New Delhi, 11th Edition, 2012.

REFERENCE BOOKS

1. Thomas N. Duening and John M. Ivancevich, "Management – Principles and Guidelines", Dreamtech Press; 1st Edition, 2012.
2. Samuel C. Certo, "Modern Management", Prentice Hall, New York, 9th Edition, 2012.
3. Schermerhorn, Capling, Poole and Wiesner, "Management", Wiley, New York, 6th Edition, 2012.
4. John A. Parnell, "Strategic Management – Theory and Practice", Cengage Publications, 2018.
5. Lawrence R Jauch, R. Gupta and William F. Glucek, "Business Policy and Strategic Management Science", McGraw Hill, New York, 5th Edition, 2012.

<table>
<tr><td>Course Title</td><td colspan="4">Environmental Science</td><td>Course Type</td><td colspan="2">FC</td></tr>
<tr><td>Course Code</td><td>B20AS0303</td><td>Credits</td><td colspan="2">2</td><td>Class</td><td colspan="2">IV Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td>IA</td><td>SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td rowspan="2">50 %</td><td rowspan="2">50 %</td></tr>
<tr><td>Total</td><td>2</td><td>2</td><td>2</td><td>26</td></tr>
</table>

COURSE OVERVIEW

This introductory course is designed to introduce you to the foundational concepts of environmental engineering, types of resources, biodiversity, threats and methods of conservation, sources and control measures of environmental pollution and ways to protect the environment.

COURSE OBJECTIVES

1. Graduates will be familiar with current and emerging environmental engineering and global issues, and have an understanding of ethical and societal responsibilities.
2. Graduates will have the ability to obtain the knowledge, and will recognize the need for engaging in life-long learning.
3. Will find the need of various types of energy (conventional & non-conventional) resources and natural resources.
4. Acquire knowledge with respect to biodiversity, threats, conservation and appreciate the concept of ecosystem.
5. Acquire knowledge about sources, effects and control measures of environmental pollution, degradation and waste management.
6. Explore the ways for protecting the environment.

COURSE OUTCOMES (Cos)

After the completion of the course, the student will be able to:

CO	Course Outcomes	Pos	PSOs
CO1	Understand, analyze and execute favorable environmental conditions and the role of individual, government and NGO in environmental protection.	1,7,8,10,12	3
CO2	List the causes, effects & remedial measures and find ways to overcome them by suggesting the pollution-controlled products	1,7,8,10,12	3
CO3	Classify different wastes, sources of waste and their effect on population.	1,7,8,10,12	3
CO4	Get motivation to find new renewable energy resources with high efficiency through active research and innovation.	1,7,8,10,12	3
CO5	Critically analyze the ecological imbalances and provide recommendations to protect the environment.	1,2, 7,8,10,12	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3	√					
CO4		√				
CO5		√				

COURSE ARTICULATION MATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1						3	1		1		2			1
CO2	1						3	1		1		2			1
CO3	1						3	1		1		2			1
CO4	1						3	1		1		2			1
CO5	1	1					3	1		1		2			1
Average	1	1					3	1		1		2			1

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENTS

THEORY

Unit – 1

Basics of environment: Introduction & definition to Environment, objectives and guiding principles of environmental education, Components of environment, Structure of atmosphere, Sustainable environment/Development, Impact of technology on the environment in terms of modern agricultural practices and industrialization, Environmental Impact Assessment.

Environmental protection: Role of Government - Assignments of MOEF, Functions of central and state boards, Institutions in Environment and People in Environment, Environmental Legislations, Initiative and Role of Non-government organizations in India and world.

Unit-2

Environmental Pollution: Definition, sources and types, Pollutant-Definition & classification, Concepts of air pollution, water pollution, Soil pollution, Automobile Pollution-Causes, Effects & control measures.

Environmental degradation: Introduction, Global warming and greenhouse effect, Acid rain-formation & effects, Ozone depletion in stratosphere and its effect.

Waste management: Municipal solid waste, biomedical waste and Electronic waste (E-Waste).

Unit-3

Energy: Definition, classification of energy resources, electromagnetic radiation-features and applications, Conventional/Non-renewable sources – Fossil fuels based (Coal, petroleum & natural gas), nuclear energy, Non-conventional/renewable sources – Solar, wind, hydro, biogas, biomass, geothermal, ocean thermal energy, Hydrogen as an alternative as a future source of energy.

Natural resources: Water resource - Global water resource distribution, Water conservation methods, Water quality parameters, Uses of water and its importance. Mineral resources - Types of minerals, Methods of mining & impacts of mining activities. Forest wealth - Importance, Deforestation-Causes, effects and controlling measures

Unit-4

Ecology:-Definition, branches, objectives and classification, Concept of an ecosystem – Structure and functions,

Ecosystem: Characteristics of an Ecosystem - Ecosystem Resilience, Ecological succession and productivity, Balanced ecosystem, Components of ecosystem-abiotic and biotic, biological diversity. Biogeochemical cycles and its environmental significance – Carbon and nitrogen cycle, Energy flow in ecosystem, food chains –types, food web & Ecological Pyramids.

Field Work: Visit to waste water treatment and biogas plant at REVA university campus, and/or Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.

TEXT BOOKS

1. R.J. Ranjit Daniels and Jagadish Krishnaswamy, "Environmental Studies", Wiley India Private Ltd., New Delhi, Co-authored & Customised by Dr.MS Reddy & Chandrashekar, REVA University, 1st Edition, 2017.
2 R.J. Ranjit Daniels and Jagadish Krishnaswamy, "Environmental Studies", Wiley India Private Ltd., New Delhi, 2nd Edition, 2014.
3. Benny Joseph, "Environmental Studies", Tata McGraw – Hill Publishing Company Limited, New Delhi, 2nd Edition, 2008.

REFERENCE BOOKS

1. Dr.S.M.Prakash, "Environmental Studies", Elite Publishers, Mangalore, 2nd Edition, 2009.
2. Rajagopalan R, "Environmental Studies – from Crisis to cure", Oxford University Press, New Delhi, 3rd Edition, 2016
3. Anil Kumar Dey and Arnab Kumar Dey, "Environmental Studies", New age international private limited publishers, New Delhi, 2nd Edition, 2007.
4. Michael Allaby, "Basics of environmental Science", Routledge-Tayler & Francis e-library, New York, 2nd Edition, 2002.

5. Dr.Y.K Singh, “Environmental Science”, New age international private limited publishers, New Delhi, 1st Edition, 2006

JOURNALS/MAGAZINES

1. International Journal of Environmental Science and Technology, https://www.springer.com/journal/13762/.
2. Journal of Environmental Sciences, https://www.journals.elsevier.com/journal-of-environmental-sciences.

SWAYAM/NPTEL/MOOCs

1. Environmental Studies: https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
2. Environmental Studies: https://nptel.ac.in/courses/120/108/120108004/

SELF-LEARNING EXERCISES

1. Discussion on the need for public awareness on the environment, Gaia Hypothesis
2. Case studies of London smog, Bhopal gas tragedy, marine pollutions and study of different waste water treatment processes, Disaster management, early warning systems-bio indicators for Tsunami and other natural disasters.
3. Hydrology & modern methods adopted for mining activities, remote sensing and its applications, Chernobyl (USSR) nuclear disaster and Fukushima (Japan) nuclear disaster.
4. Discussion on the need for balanced ecosystem and restoration of degraded ecosystems.

Course Title	**Universal Human Values**				**Course Type**		**FC**	
Course Code	**B20AHM401**	**Credits**	**0**		**Class**		**III Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	2	2				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**0**	**2**	**2**	**26**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Basic human values refer to those values which are at the core of being human. The values which are considered basic inherent values in humans include truth, honesty, loyalty, love, peace, etc. because they bring out the fundamental goodness of human beings and society at large. Tis subject focuses on developing holistic perspective and harmony on self-exploration among individuals, family and society.

COURSE OBJECTIVES

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Understand the significance of value inputs in a classroom and start applying them in their life and profession.	3,6,7,8,9,	
CO2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.	3,6,7,8,9,10	
CO3	Understand the role of a human being in ensuring harmony in society and nature.	3,6,7,8	
CO4	Demonstrate the role of human being in the abetment of pollution	3,6,7,9	
CO5	Describe appropriate technologies for the safety and security of the society as responsible human being.	9,10,11,12	

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO6	Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	9,10,11,12	

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√	√			
CO2	√	√			√	
CO3		√				
CO4			√		√	
CO5		√				√
CO6				√	√	

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			1			3	3	3	3	3					
CO2			1			3	3	3	3	3					
CO3			1			3	3	3							
CO4			1			3	3		3						
CO5									3	3	3	2			
CO6									2	3	3	2			

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY

Unit- 1

Happiness and Prosperity: A look at basic Human Aspirations. Right understanding, Relationship, basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly, Method to fulfil human aspirations: understanding and living in harmony at various levels, Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seeker and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.

Unit- 2

Understanding values in human-human relationship: meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family

Unit- 3

Understanding the harmony in the Nature: Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence. Include practice

sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Unit- 4

Natural acceptance of human values: Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations

TEXT BOOKS

1. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics", Excel Books, New Delhi, 2010.
2. A.N Tripathy, "Human Values", New Age Intl. Publishers, New Delhi, 2004.
3. R.R. Gaur, R. Sangal and G.P. Bagaria, "A Foundation Course in Human Values and Professional Ethics", Excel Books, New Delhi, 2010
4. Bertrand Russell, "Human Society in Ethics & Politics", Routledge Publishers, London, 1992

REFERENCE BOOKS

1. Corliss Lamont, "Philosophy of Humanism", Humanist Press, London, 1997
2. I.C. Sharma, "Ethical Philosophy of India", Nagin & Co Julundhar, 1970
3. Mohandas Karamchand Gandhi, "The Story of My Experiments with Truth", Navajivan Mudranalaya, Ahmadabad, 1993
4. William Lilly, "Introduction to Ethics", Allied Publisher, London, 1955

JOURNALS/MAGAZINES/ONLINE COURSES:

1. Value Education websites, http://uhv.ac.in, http://www.uptu.ac.in
2. Story of Stuff, http://www.storyofstuff.com
3. Al Gore, An Inconvenient Truth, Paramount Classics, USA
4. Charlie Chaplin, Modern Times, United Artists, USA
5. IIT Delhi, Modern Technology – the Untold Story
6. Gandhi A., Right Here Right Now, Cyclewala Production

SELF-LEARNING EXERCISES:

1. Observe that each one of us has Natural Acceptance, based on which one can verify right or not right for him. Verify this in case of i) What is Naturally Acceptable to you in relationship- Feeling of respect or disrespect? ii) What is Naturally Acceptable to you – to nurture or to exploit others? Is our living the same as your natural acceptance or different?
2. Out of the three basic requirements for fulfilment of your aspirations- right understanding, relationship and physical facilities, observe how the problems in your family are related to each. Also observe how much time & effort you devote for each in your daily routine.
3. Choose any two current problems of different kind in the society and suggest how they can be solved on the basis of natural acceptance of human values. Suggest steps you will take in present conditions.

5th Semester

<table>
<tr><td>Course Title</td><td colspan="4">Design of Machine Elements</td><td>Course Type</td><td>Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ER0501</td><td>Credits</td><td colspan="2">4</td><td>Class</td><td>V semester</td></tr>
<tr><td rowspan="2">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td rowspan="2">Total Number of Classes Per Semester</td><td rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
</table>

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

	Practice	0	0	0	Theory	Tutorial	IA	SEE
	Tutorial	1	2	2				
	Total	**4**	**5**	**5**	**39**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Design of Machine elements deals with the basics of design concepts of the structural members, failure theories, stress concentration, fatigue failure. This course covers theories of failure, shafts design, riveted and bolted joints, power screws and impact strength

COURSE OBJECTIVES

1. To understand the concept of normal, shear and torsional stress, codes and standards in the engineering in relevance to mechanical engineering.
2. To know the concept of static & impact strength in machine elements and theories of failure.
3. To understand the fatigue failure.
4. To explain the design procedure of design of shafts.
5. To introduce the concept of safe design of riveted and bolted joints in industry applications.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Apply concepts of mechanics of materials to estimate the stresses in a machine element and predict failure of components based on theories of failure	1,2	1,2
CO2	Evaluate the effect of impact and fatigue load on machine elements and factors affecting it.	1,2	1,2
CO3	Analyze the effect of stress concentration for various machine elements	1,2	1,2
CO4	Design machine elements like Shafts, Knuckle and Cotter joints	1,2,3	1,2
CO5	Compute the efficiency of temporary and permanent joints	1,2	1,2
CO6	Calculate the performance characteristics Fasteners and Power screws.	1,2	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2					✓	
CO3				✓		
CO4					✓	
CO5					✓	
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3	2	
CO2	3	3											3	3	
CO3	3	3	2										3	2	
CO4	3	2											3	3	
CO5	3	3											3	3	
CO6	3	2											3	2	
Average	**3**	**2.5**											**3**	**2.5**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit – 1

Introduction: Definitions: normal, shear, biaxial and triaxial stresses, Stress tensor, Principal stresses. Stress-strain diagrams for ductile and brittle materials, Failure of brittle materials, Failure of ductile materials, Factor of Safety Design considerations: Codes and Standards.

Design for Static Strength: Static loads subjected to Axial, Bending and torsion loads.

Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory, Stress concentration, Determination of stress concentration factor, simple numerical.

Unit – 2

Impact strength: Introduction, Impact stresses due to axial & bending load. Simple numerical.

Design for Fatigue Strength: Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Endurance limit modifying factors, size effect, surface effect, Stress concentration effects; Goodman's and Soderberg's relationship Simple numerical

Unit – 3

Design of Shafts: Materials for shaft, Torsion of shafts, Design of solid and hollow shafts for strength and rigidity – design of shafts for combined bending and axial loads.

Design of Temporary Joints: knuckle joint and cotter joint.

Design of Permanent joints

Riveted joints: Types, rivet materials, failures of riveted joints, Joint efficiency, Boiler joints (Longitudinal joints), Riveted Brackets.

Welded Joints: Types, strength of butt and fillet welds, eccentric loading.

Unit – 4

Threaded Fasteners: Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static, dynamic and eccentric loading

Power Screws: Mechanics of power screw, Stresses in power screws, efficiency and self-locking, simple numerical.

CASE STUDIES:

1. A 32 inch LED TV is decided to be mounted on a clamp. Identify the number of bolts and the profile of clamp which has to withstand the maximum load on the branded TV.
2. Analyze the stress patterns on a clamping plate used to connect the shaft of 100mm diameter.
3. A pedestal fan is to cool the room of 10x8 size. Determine the forces and stresses induced in the rotating shaft and check for safety of the fan.
4. A centrifuge is rotating at 1000rpm to separate butter from curd. Determine the stresses induced and the safety of the equipment.
5. Design a member to absorb an impact load of 80kN falling with a velocity of 25 m/s.
6. Design the bolt of an excavator which is used to lift the debris from the ground of 150 m depth.
7. A GI Sheet is used to cover a boiler of particular diameter. Identify and suggest the type of riveting for fixing the sheet on boiler surface and the diameter of the rivet.

TEXT BOOKS

1. Joseph E Shigley and Charles R. Mischke, "Mechanical Engineering Design", McGraw Hill International Edition, 6th Edition 2009.
2. V.B. Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Edition 2017.
3. Dr. P C Sharma and Dr. D K Aggarwal, "Machine Design", S. K. Kataria & Sons, 13th Edition 2017.

DATA HAND BOOKS

1. K. Lingaigh, "Machine Design Databook", McGraw Hill Education, 2nd Edition 2017.
2. K.Mahadevan and B.Reddy, "Design Data Hand Book", CBS Publisher, 4th Edition, 2018.

REFERENCE BOOKS

1. Robert L. Norton, “Machine Design”, Pearson Education Asia, 2001.
2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, “Design of Machine Elements”, Pearson Education, 2006.
3. Hall, Holowenko, Laughlin (Schaum’s Outlines series), “Machine Design“, Adapted by S.K. Somani, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/topics/engineering/design of machine elements
2. https://link.springer.com/book/10.1007/978-3-319-06086-6

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in
2. https://nptel.ac.in/courses

<table>
<tr><td>Course Title</td><td colspan="4">Fluid Mechanics and Machines</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ER0502</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">V Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Tutorial</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>1</td><td>2</td><td>2</td></tr>
<tr><td>Total</td><td>3</td><td>4</td><td>4</td><td>26</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Fluid Mechanics and Machines aims to deal with the behavior of fluids under rest and in motion. The course deals with types of fluids, properties of fluids, fluid statics, pressure measurement, fluid kinematics and fluid dynamics. This course also emphasizes the basic fluid mechanics principles and energy transfer in a hydraulic machines along with their performances. The course also highlights the viscous flow and forces over immersed bodies.

COURSE OBJECTIVES

1. To introduce fluid properties, measurement of fluid pressure and behavior of fluids at rest.
2. To identify the flow characteristics and dynamics of flow field for Engineering Applications.
3. To describe the importance of major and minor losses of fluid flows through pipes.
4. To discuss the main properties of viscous flow and flow over the immersed bodies.
5. To analyze the velocity components and energy transfer in fluid machines.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Apply the fluid properties and basic laws for analyzing fluid static applications.	1,2	1,2
CO2	Apply the principles of fluid kinematics, fluid dynamics and dimensional analysis for solving the fluid flow problems.	1,2,5	1,2
CO3	Evaluate the major and minor losses of fluid flow through pipes.	1,2	1,2
CO4	Apply the fundamentals of fluid flow for analyzing flow of viscous fluid through pipes and around immersed bodies.	1,2	1,2
CO5	Apply the fundamental concepts of energy conversion principles for analyzing fluid flow through generalized turbomachines.	1,2	1,2
CO6	Evaluate the performance parameters of power absorbing and power generating turbomachines.	1,2	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2			✓			
CO3			✓			
CO4				✓		
CO5			✓			
CO6					✓	

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3	2	
CO2	3	2			2								3	2	
CO3	3	3											3	2	
CO4	3	3											3	2	
CO5	3	3											3	2	
CO6	3	3											3	2	
Average	**3**	**2.7**			**2**								**3**	**2**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Definition of a fluid, Properties of fluids, Newton's law of viscosity, types of fluid, Numerical on viscosity.

Fluid Statics: Pascal's law, Hydrostatic law, absolute, gauge, atmosphere and vacuum pressure, Manometers- simple and differential manometers. Discussion on Total pressure, Centre of pressure, Buoyancy, Centre of buoyancy, Metacenter and Meta centric height, Numerical.

Unit-2

Fluid kinematics: Types of fluid flow, flow lines, three dimensional continuity equation in (Cartesian co-ordinate system), velocity and acceleration, Discussion on velocity potential function and stream function.

Fluid Dynamics: Euler's equation of motion along stream line, Bernoulli's equation and its limitations, Applications of Bernoulli's theorem on flow measuring devices, Numerical.

Dimensional Analysis: Dimensional Homogeneity, Methods of dimensional analysis- Rayleigh's method, Buckingham π theorem, Numerical. Discussion on Similitude and Model studies.

Unit-3

Flow through pipes: Frictional loss in pipe flow, Darcy-Weisbach equation and Chezy's equation for loss of head due to friction in pipes, Discussion on minor loses in pipes, hydraulic gradient line and total energy line, Numerical.

Viscous flow: Reynolds Number, Laminar flow through circular pipes, Hagen – Poiseuille equation. (No-derivation), Numerical.

Flow over immersed bodies: Introduction, Lift and drag forces, Coefficient of lift and drag forces, Numerical.

Unit-4

Energy Exchange in Fluid machines: Fluid flow through a generalized turbomachine, Euler's turbine equation.

Centrifugal Pumps: Parts of centrifugal pump, different heads and efficiencies of centrifugal pump, minimum speed
for starting the pump, Work done by the Centrifugal pump, Pumps in series and parallel. Numerical.

Hydraulic Turbines: Classification, efficiencies of hydraulic turbines. Pelton turbine - velocity triangles, design parameters, Francis turbine - velocity triangles, design parameters, Kaplan- velocity triangles, design parameters. Numerical.

CASE STUDIES:

1. Develop a python programming for plot and visualization of stream line of fluid flow.
2. Conduct the experiment to determine the coefficient of friction for fluid flowing through pipes of different diameter and compute the same using MAT lab.
3. Prepare a report on any pumps used in Agricultural field/ Industry by mentioning following details: Make and specifications, operating conditions, construction, working principle, and applications.
4. Prepare a report on any Mini or Macro hydroelectric power station by mentioning the following details: Make and specifications, type and of number of turbines, capacity of power generation, working principle, operating conditions and applications.

TEXT BOOKS

1. Dr. Bansal, "A text book of Fluid Mechanics and Hydraulic Machines", R.K.Lakshmi Publications Pvt. Ltd, 9th Edition, 2018.

2. Jagadish Lal, "Fluid Mechanics and Hydraulic", Metropolitan Book Company, 4th Edition 2012.

REFERENCE BOOKS

1. Yunus A. Cengel and John M.Cimbala, "Fluid Mechanics (SI Units)", Tata McGraw Hill, 4th Edition 2019.

2. Pijush.K.Kundu, "Fluid Mechanics", Taylor & Francis, 3rd Edition, 2015.

JOURNALS/MAGAZINES

1. https://www.cambridge.org/core/journals/journal-of-fluid-mechanics

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc22_me31/preview
2. https://www.my-mooc.com/en/categorie/mechanical-engineering

Course Title	Thermal Engineering Systems				Course Type		Hard Core	
Course Code	B20ER0503	Credits	4		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	4	4	4				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**4**	**4**	**4**	**52**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Thermal Engineering plays an important role in design of many Mechanical, electrical and electronics system. The course deals with Internal Combustions engines, combustion thermodynamics, psychometry, air conditioning, boilers, gas turbines and jet propulsions. It also deals with evaluation of condenser performance and boiler efficiency.

COURSE OBJECTIVES

1. To study the classification testing and performance evaluation of IC Engines.
2. To understand the basic definitions, concepts of chemical reactions involved in combustion process.
3. To gain the knowledge about basic definitions and concepts of psychometry and air-conditioning.
4. To study different types and working principles of boilers, condensers, accessories and evaluation of boiler performance.
5. To evaluate the performance parameters of gas turbine and Jet Propulsion systems.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs

CO1	Evaluate the performance of I.C Engines.	1,2	1,2
CO2	Analyze the combustion processes using thermodynamic principles.	1,2	1,2
CO3	Apply the concept of psychometry to evaluate the performance of air-conditioning systems.	1,2	1,2
CO4	Identify and select the suitable boiler mountings and accessories to improve the performance of boiler.	1,2	1,2
CO5	Compute the thermal parameters to improve thermal efficiency of gas turbines.	1,2	1,2
CO6	Describe classification and working principles jet propulsion systems.	1	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6		√				

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											1	2	
CO2	3	3											1	3	
CO3	3	3											1	2	
CO4	3	2											1	2	
CO5	3	2											1	2	1
CO6	3	2											1	2	
Average	**3**	**2.3**											**1**	**2.2**	**1**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

I.C.Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, heat balance sheet, Morse test, IC Engine fuels, Ratings and Alternate Fuels**.**

Combustion Thermodynamics: Theoretical (Stoichiometric) air for combustion of fuels. Excess air, balancing of combustion equations, Exhaust gas analysis, A/F ratio, Enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency.

Unit-2

Psychometrics: Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams.

Air Conditioning Systems: Process in air conditioning: Summer air conditioning, winter air conditioning and year round air conditioning.

Unit-3

Boilers: Steam generators-classifications. Working of fire-tube and water-tube boilers, boiler mountings & accessories, air pre heater, feed water heater, super heater. Boiler efficiency. Condenser: Classification of condenser, Air leakage, Condenser performance parameters.

Unit-4

Gas Turbines : Classification of Gas turbines; Gas turbine (Brayton) cycle; description and analysis of open cycle gas turbine; Derivations of equations for efficiency, work ratio and Pressure ratio for maximum power output; actual gas turbine cycles; Numerical problems Methods to improve thermal efficiency of gas turbines

Jet Propulsion: Introduction to the principles of jet propulsion, Turbojet and turboprop engines & their processes, Principle of rocket propulsion, Introduction to Rocket Engine.

CASE STUDIES

1. Develop a python programming for analyzing (drawing PV diagram) the diesel cycle.
2. Prepare a report on causes of boiler and mountings accidents.
3. Prepare a brief report on specifications of latest IC engines used latest in new vehicles.
4. Prepare a report on cooling load and specifications of air-condition systems used in offices or residential places.

TEXT BOOKS

1. P.K. Nag "Engineering Thermodynamics" Tata McGraw Hill, 6th Edition 2018.
2. Ganesan V, "Gas Turbines Tata McGraw Hill, 3rd Edition, 2010.
3. Domkundwar and Arora, "Power Plant Engineering" Dhanpat Rai & Co, 5th Edition, 2010.

REFERENCE BOOKS

1. Saravanamuttoo, H.I.H., Rogers, G.F.C. and Cohen, H., "Gas Turbine Theory" Pearson Education Limited, 5th Edition 2013.
2. Rajput R.K, Thermal Engineering. Lakshmi publications, 10th Edition, 2020.
3. R.B.Mathur and R.P.Sharma, "Internal Combustion Engines", Dhanpat Rai & Sons, 2nd Edition, 2018.
4. Yunus A. Cenegal and Michael A. Boles, "Thermodynamics -An Engineering Approach", Tata McGraw-Hill, 9th Edition, 2019.
5. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill, Prentice-hall of India Pvt. Ltd, 1st Edition, 2010.

JOURNALS/MAGAZINES:

1. International Journal of Heat and Mass Transfer
2. American Institute of Aeronautics and Astronautics

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/browse/physical-science-and-engineering/mechanical-engineering
2. https://www.my-mooc.com/en/categorie/mechanical-engineering
3. https://nptel.ac.in/cours

<table>
<tr><td>Course Title</td><td colspan="4">Smart Materials</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ERS511</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">V Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Overview of the course is to enhance holistic development of students and improve their knowledge about the smart materials, MR, ER fluids, Biomimetics and smart actuators, advanced in smart structures, smart composites and applications of smart materials.

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

COURSE OBJECTIVES

The objectives of this course are to:

1. Understand the basic concepts of composites and ceramics materials, electro-magnetic materials and shape memory alloys
2. Study about the MR and ER fluids, High-Band Width, Low Strain Smart Sensors and Application of Smart Sensors for Structural Health Monitoring (SHM)
3. Analyze the smart actuators and smart composites, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control and Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Apply the fundamental knowledge of smart materials, smart structures, piezoelectric, MR, ER fluids to solve problems in the field of medicine and engineering.	1	1
CO2	Identify, compare and contrast alternative solution processes to select the best process of smart actuators in automobiles and biomedical field.	1, 2	1
CO3	Generate information through appropriate tests to improve or revise the design of smart composites.	1, 2, 3	2
CO4	Recognize the need of analysis to good problem definition of smart structures.	1, 2, 3	2
CO5	Establish a relationship between measured data and underlying physical principles smart composites applications for corrosion coating and self-healing and MEMs products.	1, 2, 3,4	3
CO6	Examine the relevant methods and techniques of advances in Sensing applications of smart sensors of structural health monitoring.	1, 2, 3,4,5	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3			✓			
CO4			✓			
CO5				✓		
CO6				✓		

COURSE ARTICULATION MATRIX

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2		
CO2	3	2											2		
CO3	3	2	1										1	2	
CO4	3	2	1										1	2	
CO5	3	3	1	1									1	2	2
CO6	3	2	1	1	1								1	2	2
Average	**3**	**2.2**	**1**	**1**	**1**								**1.3**	**2**	**2**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Overview of Smart Materials: Introduction to Smart Materials - Smart structures - classification of smart structures, common smart materials. Piezoelectric materials, piezoelectric effect, Piezoceramics, Piezopolymers, Shape memory alloys (SMAs) - Shape memory effect - Shape memory polymers, Introduction to Electro-active Materials, Electro-active Polymers, Ionic Polymer - Electro-rheological Fluids - Magneto Rhelological Fluids.

Unit-2

Smart Actuators: Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto-volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control**.**

Unit-3

Smart composites: Review of Composite Materials, Micro and Macro-mechanics, Laminated Composites based on the Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, governing Equation of Motion. Advances in smart structures; Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials.

Unit-4

Applications: Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, MEMS - MEMS Product development - Deployment devices - Molecular machines.

Sensing Applications; Piezeoelctric Strain Sensors, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM).

TEXT BOOKS

1. Mohsini Shahenpoor (Ed.), “Fundamentals of Smart Materials”, RSC, Cambridge, UK, 2020
2. Chander Prakash, Sunpreet Singh, J. Paulo Davim (Ed.), Functional and Smart Materials, CRC Press, 1st Edition, 2021.
3. Chang Liu, “Foundation of MEMS”, Pearson Education, 2nd edition, 2012.
4. M.V.Gandhi and B.S.Thompson, “Smart Materials and Structures”, Chapmen & Hall, London, 1992.
5. Mel M. Schwartz, “Smart Materials”, CRC Press, 1st Edition, 2009.
6. Donald J. Leo, “Engineering analysis of smart material systems”, John Wiley & Sons, 1st Edition, 2007.

REFERENCE BOOKS

1. Radhashyam Rai, “Smart Materials for Smart Living”, Nova Publishers, USA, 2017.
2. Qun Wang (Ed.), “Smart Materials for Tissue Engineering”, RSC, UK, 2017.
3. Johannes Michael Sinapius, Adaptronics – “Smart Structures and Materials”, Springer, 2020.
4. Anca Filimon (Ed.), “Smart Materials”: Integrated Design, Engineering Approaches and Potential Applications, CRC Press, 2019.
5. Vijay K. Varadan, “Smart material systems and MEMS: design and development methodologies”, John Wiley & Sons, 2006.
6. Seung- Bok Choi & Young-Min Han, “Piezoelectric actuators: control applications of smart materials”, CRC Press - 2010.
7. Kwang J. Kim & S. Tadokoro, “Electroactive polymers for robotics applications: artificial muscles and sensors”, Springer, 2007

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology
2. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/122/102/122102008/

Course Title	Experimental Stress Analysis				Course Type		Soft Core	
Course Code	B20ERS512	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Experimental Stress Analysis is the analysis of the mechanical stress state in materials, which is performed through experiments using strain gauge measurements. This course covers the Electrical Strain Gauges, Strain Rosettes, Photo-Elasticity technique in Two-Dimensional & Three-Dimensional problems, Photo-elastic Coatings & Brittle Coatings, and Moire Methods.

COURSE OBJECTIVES

1. To study the working principles of different types of strain gauges
2. To know the fundamentals of photo elastic coatings
3. To understand the photo elastic technique for principal stress measurement on 2-D and 3-D objects
4. To study the stresses in 2-D & 3-D photo elastic materials by different techniques.
5. To provide geometric and displacement Moire fringe techniques.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Outline the basics of experimental methods commonly used in real time problems.	1,2	1,2
CO2	Illustrate the Photo-Elasticity principles in Two-Dimensional stress analysis.	1,2	1,2
CO3	Examine the Photo-Elasticity principles in Three-Dimensional stress analysis.	1,2,3	1,2
CO4	Analyze the coating stress in the Photo-elastic Coatings.	1,2,4	1,2
CO5	Differentiate the types of brittle Coatings and Crack detection methods.	1,2	1,2
CO6	Distinguish the surface strains using Moire fringes techniques.	1,2	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3		✓				
CO4			✓			
CO5			✓			
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3	2	
CO2	3	3											3	3	
CO3	3	3	1										3	2	

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO4	3	2		1									3	3	
CO5	3	3											3	3	
CO6	3	2											3	2	
Average	3	2.5	1	1									3	2.5	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Electrical Strain Gauges: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheat stone's bridges.

Strain Rosettes: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, and Stress intensity factor gage.

Unit-2

Photo-Elasticity: Nature of light, Wave theory of light - optical interference, Stress optic law – effect of stressed model in plane and circular polariscopes, Isoclinics & Isochromatic, Fringe order determination Fringe multiplication techniques.

Two Dimensional Photo-elasticity: Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo-elastic model materials, materials for 2D photo elasticity.

Unit-3

Three-Dimensional Photo elasticity: Stress freezing method, scattered light photoelasticity, scattered light as an interior analyzer and polarizer, Scattered light Polari scope and stress data Analyses.

Photo-elastic (Bi-fringe) Coatings: Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poisson's, Stress separation techniques: Oblique incidence, Strip coatings.

Unit-4

Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.

Moire Methods: Moire fringes produced by mechanical interference. Geometrical approach, Displacement field approach to Moire fringe analysis, out of plane displacement measurements, Out of plane slope measurements. Applications and advantages.

CASE STUDIES

1. Determine the different types of stresses acting on a motorcycle handle using strain gauges.
2. Determine the stress distribution in a rectangular plate with rectangular cut out using photoelasticity.
3. Using Moire method determine the deformation in thin sheet metals**.**

TEXT BOOKS

1. Dally J W and Riley W F, "Experimental Stress Analysis", McGraw Hill Inc New York, 2014.
2. Sadhu Singh, "Experimental Stress Analysis", Khanna Publisher New Delhi, 2009.
3. Srinath L.S., "Experimental stress Analysis", Tata McGraw Hill, New Delhi, 1984.

REFERENCE BOOKS

1. Jindal, "Experimental stress analysis", Pearson Publishers, 2018.
2. J.Srinivas, "Stress analysis-An introduction to Experimental Techniques", Narosa Publishers, 2015.
3. Mubin Khanna, "Experimental Stress Analysis", 2003.
4. Freddi, Olmi, Cristofolini, "Experimental stress analysis for materials and structures", Springer, 2015

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/topics/engineering/experimental-stress-analysis

2. https://link.springer.com/book/10.1007/978-3-319-06086-6

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_me02/preview
2. https://nptel.ac.in/courses/112106068

Course Title	Energy Technology				Course Type		Soft Core	
Course Code	B20ERS513	Credits	3		Class		V semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

This course explores the concept of thermal energy conversion, also introduces the, different types of fuels used for steam generation and equipment for burning coal in lump form. This course introduces to bio mass energy and its characteristics. It also emphasizes on conversion of various biomass energy into solid, liquid and gaseous forms. Further the course deals with conversion of biomass into methanol, ethanol, biogas, bio diesel etc.

COURSE OBJECTIVES

1. To understand energy scenario, energy sources and their utilization
2. To gain the knowledge about diesel engine power plant.
3. To enhance the knowledge about renewable energy sources.
4. To enable the students to gain the knowledge on hydrogen energy generation.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Summarize the basic concepts of thermal energy systems and identify coal and ash handling systems used in steam power plants.	1	1
CO2	Identify renewable energy resources and their utilization.	1,6,7	1
CO3	Discuss the principles of energy conversion of wind, geothermal, ocean, biomass, and biogas energy systems.	1,6,7	1,2
CO4	Describe the methods used to generate Hydrogen energy.	1, 7	1
CO5	Describe the main characteristics of renewable energy sources and their comparison with fossil fuels.	1,6,7	1
CO6	Investigate the design parameters of biogas digesters.	1,2,3,7	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3			√			
CO4		√				
CO5		√				
CO6				√		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3					2	2						3		
CO3	3	2				2	2						3	2	
CO4	3						1						3		
CO5	3					2	1						3		
CO6	3	2	1										3	1	1
Average	**3**	**2**	**1**			**2**	**1.5**						**3**	**1.5**	**1**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Thermal Energy Conversion System: Review of energy scenario in India, General Philosophy and need of Energy, Different Types of Fuels used for steam generation, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace,

Coal and Ash Handling: Chimneys: Natural, forced, induced and balanced draft, Cooling towers and Ponds

Unit-2

Diesel Engine Power System: Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant.

Solar Energy and Applications: Solar radiation - Availability- Measurement and estimation- Solar radiation geometry

Hydrogen Energy: Introduction to hydrogen energy, methods of hydrogen production (electrolytic and thermo chemical method).

Unit-3

Wind Energy: Wind energy - General considerations - Wind Power plant design – Horizontal axis wind turbine

Tidal Power: Power generation using OTEC - Wave and Tidal energy - Scope and economics - Limitations**.**

Hydro-Electric Energy: General layout of hydel power plants, Hydrographs, flow duration and mass curves and numerical. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks, gates and valves.

Unit-4

Biomass Energy Sources: Biomass production for energy farming, origin of Biomass-Photosynthesis process, Energy through fermentation -Ethanol Production from sugarcane and starch, Biomass characteristics.

Bio-Methanization: Anaerobic digestion, Basic principles, factors affecting biogas yield, biogas digester (floating gas holder and fixed dome type with working principle and diagram).

Geothermal Energy Conversion: Availability - Geographical distribution.

CASE STUDIES

1. Prepare the report on Thermal power plants in INDIA.
2. Prepare the report on Diesel and Hydel power plants in Karnataka.
3. Study on Wind Energy distribution/resources across Karnataka.
4. Parameters to be considered foe site selection of hydroelectric power plant.

TEXT BOOKS

1. P.K Nag, “Power Plant Engineering”, Tata McGraw Hill, 4th Edition, 2017.
2. Morse F.T “Power Plant Engineering”, Van Nostrand Reinholdire, 3rd Edition, 1953.
3. B H Khan, “Non-conventional energy resources”, McGraw Hill Education, 3rd Edition, 2017.
4. A. W. Culp Jr, “Principles of Energy conversion”, McGraw Hill, 2nd Edition, 2000.

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

REFERENCE BOOKS

1. Stanier, “Plant Engg. Hand Book, McGraw Hill, 1998.
2. Domakundawar, “Power Plant Engineering”, Dhanpath Rai & Co, 5th Edition, 2008
3. S.P. Sukhatme, “Solar Energy: principles of Thermal Collection and Storage”, Tata McGraw-Hill, 3rd Edition, 2009.
4. L.L. Freris, “Wind Energy Conversion Systems”, Prentice Hall, 1990.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/topics/engineering/ash-handling-plant
2.https://www.researchgate.net/publication/267838546_Survey_of_modern_power_plants_driven_by_diesel_and_gas_engines.
3. https://www.journals.elsevier.com/international-journal-of-hydrogen-energy
4. https://www.sciencedirect.com/science/article/pii/S2211467X19300379

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_me86/preview
2. https://nptel.ac.in/courses/103107157
3. https://onlinecourses.nptel.ac.in/noc21_ch11/preview
4. https://onlinecourses.nptel.ac.in/noc22_ch27/preview

Course Title	**Automotive Engineering**				**Course Type**		**Soft Core**	
Course Code	**B20ERS514**	**Credits**	**3**		**Class**		**V semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with the components used in automotive like, engine transmission system, braking system and fuel supply system. It emphasizes on emissions, emitting from various types of vehicles, emission norms and methods of controlling emissions. This course explores the necessity of cooling and lubricating system, the advance ignition systems, steering and brake system to control the vehicles.

COURSE OBJECTIVES

1. To understand the construction and working of components used in petrol and diesel engines.
2. To explore functions of electrical components used in Ignition system of an automobile.
3. To explain the importance of emission control, alternate fuels and engine modifications for alternate fuels.
4. To recognize the need for safety and comfort in automobiles.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the construction and working of engine components, cooling and lubrication systems	1	1
CO2	Illustrate the working of automotive fuel supply systems and their limitations	1	1
CO3	Demonstrate knowledge of engine emissions, its control and emission standards for sustainable development.	1,6,7,8	1
CO4	Identify the different types of Ignition systems used in automobiles and interpret forced induction principles.	1, 2	1
CO5	Illustrate the construction and working of transmission systems and their components.	1	1

CO6	Recognize the different types of suspension systems, Steering systems, braking systems and describe their working principles.	1	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3		✓				
CO4		✓				
CO5		✓				
CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												1		
CO2	3												1		
CO3	3					2	2	2					1		
CO4	3	1											1		
CO5	3												1		
CO6	3												1		
Average	**3**	**1**				**2**	**2**	**2**					1		

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Engine Components, Cooling and Lubrication: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve-Timing diagram, Types of combustion chambers for S.I. Engine and C.I. Engines, choice of materials for different engine components, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements.

Unit-2

Fuel Supply System: Fuel supply in SI engines- Fuel mixture requirements for SI engines, Working principle of simple carburetors, Injection systems -Single-point body injection, multipoint fuel injection, Inline distributor pump, Common rail, fuel injection pumps and injectors.

Engine Emissions and Control Systems: Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Catalytic converter, Emission standards.

Unit-3

Ignition System, Superchargers and Turbochargers: Introduction, objectives, Ignition System Types, Comparison between Battery and Magneto Ignition System, Drawbacks (Disadvantages) of Conventional Ignition Systems, Advantages of Electronic Ignition System, Types of Electronic Ignition System, Forced Induction, Types of superchargers, Turbocharger and comparisons.

Transmission System: General arrangement of clutch, Principle of friction clutches, Torque transmitted, Fluid flywheel, Single plate, multi-plate and centrifugal clutches.

Gear Box: Necessity for gear ratios in transmission. Self-study: synchromesh gear boxes.

Unit-4

Suspension, Springs and Brakes: Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system. Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system.

Steering System: Steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer.

CASE STUDIES

1. Prepare literature survey report on "Next generation Tesla cars credibility in Indian road system".
2. Prepare literature survey report on "compare the efficiency of existing EV (Electric Vehicles) with conventional automotive vehicles".
3. Prepare report on "How to overcome existing EV (Electric Vehicles) vehicle battery system problems".
4. Prepare report on" Next-generation low carbon vehicles"
5. Prepare report on "Future of Automotive Industry with integration of software development".
6. Prepare report on "Existing EV vehicles and their comparative analysis"

TEXT BOOK:

1. Kirpal Singh, "Automobile Engineering", Volume 1&2, The world book depot, 14th Edition, 2021.
2. R.B. Gupta "Automobile Engineering", Aman Book Stall, 1st Edition, 2014.

REFERENCE BOOKS:

1. William.H.Crouse, "Automotive Mechanics", McGraw-Hill, 10th Edition, 2006.
2. Mathur and Sharma "Internal Combustion Engines", Dhanpat Rai Publications, 8th Edition, 2016.
3. V Ganesan, "Internal Combustion Engines", McGraw-Hill, 4th Edition, 2012.
4. John B Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill, 2nd Edition, 2018.

JOURNALS/MAGAZINES

1. https://www.springer.com/journal/International Journal of Automotive Technology
2. https://www.sae.org/publications/magazines/automotive-engineering
3. https://www.resurchify.com/impact/category/Automotive-Engineering

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/Fundamentals of Automotive Systems

Course Title	**Statistical Quality Control**				**Course Type**		**Soft Core**	
Course Code	**B20ERS515**	**Credits**	**3**		**Class**		**V Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

In industry, graduates are required to judge quality of raw materials, work in process and that of final products continuously to maintain quality as per requirement. This is a very important activity and involves intermittent or continuous manual or automated inspection of parameters to collect data and analyze it using statistical quality control techniques to interpret quality of raw materials, work in process and final products. Based on this need, this course has been designed to provide the necessary knowledge and skills in statistical quality control techniques.

COURSE OBJECTIVES

1. To understand the basic concepts and statistical underpinnings of quality monitoring.
2. To learn various available statistical tools and economical design issues associated with the quality monitoring.

3. To demonstrate the ability to design and implement these tools.
4. Develop strategies for conducting design of experiments in process improvements.
5. Perform Reliability evaluation of Mechanical, Electrical, Electronics and Software Technology Systems.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate the statistical methods for enhancement of quality technology and management.	1,2	1,2
CO2	Apply and examine the modern statistical methods for process quality control and improvement.	1,2, 9	1,2
CO3	Construct and interpret control charts for variables and attributes to determine their state of statistical control.	1,2,9	1,2
CO4	Analyze the various parameters of operating characteristics curve using Sampling techniques.	1,2	1,2
CO5	Perform analysis of process capability and reliability aspects of production processes.	1,2,3,9,10	1,2
CO6	Analyze the data and develop the process chart using Minitab statistical software.	1,2,3,5,9,10	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3		√				
CO4		√		√		
CO5				√		
CO6				√		

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											1	2	
CO2	3	2	1						2				1	3	
CO3	3	2	1						2				1	3	
CO4	3	2	2						2				1	3	
CO5	2	2	2										1	3	
CO6	3	3			1				2	1			1	3	
Average	**2.8**	**2**	**1**		**1**				**2**				**1**	**2.8**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Dimensions of Quality, Statistical Methods for Quality, Quality costs. Quality assurance, ISO 9000, 14000 standards. Design for Six Sigma: Overview of DMAIC phases, DFSS, DMADV Method.

Statistical Process Control: Chance and assignable causes of variation. Statistical basis of control charts, Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational sub groups. Analysis of patterns of control charts.

Unit-2

Control Charts for Variable and Attribute Data: Controls charts for mean and Range, Control charts for mean and standard deviation. Controls chart for fraction non- conforming (p, np, 100p charts), Control chart for non-conformities (c and u charts).

Process capability: Methods of estimating process capability, Process capability indices- cp and cpk

Unit-3

Advanced Control Charts: Control charts for Individual measurements, Cumulative sum, exponentially weighted moving average, Group control charts

Acceptance Sampling: Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and Consumer's Risk. AQL, LTPD, AOQL concepts- standard sampling plans for AQL and LTPD- uses of standard sampling plans.

Unit-4

Reliability and Life Testing: Failure models of components, definition of reliability, MTBF, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, parallel and series-parallel device configurations. Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy, Product life cycle.

Experimental Design for Process Improvement: General model of a process, Examples of designed experiments in process improvement, Principles of experimentation, Guidelines for designing experiments, Completely randomized designs (CRD), Randomized block designs (RBD), Factorial experiments – 22 design..

Simulation on Statistical tool (only for Assignment)

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Construction and interpretation of statistical control charts a. X-bar & R-chart b. X-bar & s-chart c. np-chart d. p-chart e. c-chart f. u-chart	Minitab software	Hands on Experience
2.	Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves	Minitab software	Hands on Experience
3.	Calculation of process capability	Minitab software	Hands on Experience

CASE STUDIES

1. Application of SQC in packaging Industry
2. Implementation of SQC and Fuzzy failure mode and effect analysis in various automobile and manufacturing sector-A case study review.
3. Assessing the Quality of product using SQC Maps: A Case study
4. SQC in MSME'S/SME'S: A case study

TEXT BOOKS

1. Grant, Eugene .L, "Statistical Quality Control", McGraw-Hill, 7th Edition, 2006.
2. L.S.Srinath, "Reliability Engineering", Affiliated East west press, 4th Edition, 2009.
3. Mahajan, "Statistical Quality Control", Dhanpat Rai, 2016.

REFERENCE BOOKS

1. Monohar Mahajan, "Statistical Quality Control", Dhanpat Rai & Sons, 2001.
2. R.C.Gupta, "Statistical Quality Control", Khanna Publishers, 6th Edition, India, 2003.
3. Besterfield D.H Quality Control, New Jersey, Prentice Hall, 1993.
4. Sharma S.C., "Inspection Quality Control and Reliability", Khanna Publishers, 2002.

JOURNALS/MAGAZINES

1. IEEE Transactions on Industrial Informatics

2. International journal of Production Research
3. Journal of Industrial Information Integration
4. International Journal of Production Research
5. International Journal of Production Economics
6. Journal of Manufacturing Technology Management
7. Journal of Product Innovation Management
8. Reliability Engineering & System Safety

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/110105088
2. https://www.udemy.com/course/statistical-quality-control-sqc/
3. https://www.udemy.com/course/mastering-statistical-quality-control-with-minitab/

Course Title	Smart Materials				Course Type		Open Elective	
Course Code	B20MEO501	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Overview of the course is to enhance holistic development of students and improve their knowledge about the smart materials, MR, ER fluids, Biomimetics and smart actuators, advanced in smart structures, smart composites and applications of smart materials.

COURSE OBJECTIVES

The objectives of this course are to:

1. Understand the basic concepts of composites and ceramics materials, electro-magnetic materials and shape memory alloys
2. Study about the MR and ER fluids, High-Band Width, Low Strain Smart Sensors and Application of Smart Sensors for Structural Health Monitoring (SHM)
3. Analyze the smart actuators and smart composites, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control and Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Apply the fundamental knowledge of smart materials, smart structures, piezoelectric, MR, ER fluids to solve problems in the field of medicine and engineering.	1	1
CO2	Identify, compare and contrast alternative solution processes to select the best process of smart actuators in automobiles and biomedical field.	1, 2	1
CO3	Generate information through appropriate tests to improve or revise the design of smart composites.	1, 2, 3	2
CO4	Recognize the need of analysis to good problem definition of smart structures.	1, 2, 3	2
CO5	Establish a relationship between measured data and underlying physical principles smart composites applications for corrosion coating and self-healing and MEMs products.	1, 2, 3,4	3
CO6	Examine the relevant methods and techniques of advances in Sensing applications of smart sensors of structural health monitoring.	1, 2, 3,4,5	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3			✓			
CO4			✓			
CO5				✓		
CO6				✓		

COURSE ARTICULATION MATRIX

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2		
CO2	3	2											2		
CO3	3	2	1										1	2	
CO4	3	2	1										1	2	
CO5	3	3	1	1									1	2	2
CO6	3	2	1	1	1								1	2	2
Average	**3**	**2.2**	**1**	**1**	**1**								**1.3**	**2**	**2**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Overview of Smart Materials: Introduction to Smart Materials - Smart structures - classification of smart structures, common smart materials. Piezoelectric materials, piezoelectric effect, Piezoceramics, Piezopolymers, Shape memory alloys (SMAs) - Shape memory effect - Shape memory polymers, Introduction to Electro-active Materials, Electro-active Polymers, Ionic Polymer - Electro-rheological Fluids - Magneto Rhelological Fluids.

Unit-2

Smart Actuators: Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto-volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control**.**

Unit-3

Smart composites: Review of Composite Materials, Micro and Macro-mechanics, Laminated Composites based on the Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, governing Equation of Motion. Advances in smart structures; Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials.

Unit-4

Applications: Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, MEMS - MEMS Product development - Deployment devices - Molecular machines.

Sensing Applications; Piezeoelctric Strain Sensors, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM).

TEXT BOOKS

1. Mohsini Shahenpoor (Ed.), "Fundamentals of Smart Materials", RSC, Cambridge, UK, 2020

2. Chander Prakash, Sunpreet Singh, J. Paulo Davim (Ed.), Functional and Smart Materials, CRC Press, 1st Edition, 2021.
3. Chang Liu, "Foundation of MEMS", Pearson Education, 2nd edition, 2012.
4. M.V.Gandhi and B.S.Thompson, "Smart Materials and Structures", Chapmen & Hall, London, 1992.
5. Mel M. Schwartz, "Smart Materials", CRC Press, 1st Edition, 2009.
6. Donald J. Leo, "Engineering analysis of smart material systems", John Wiley & Sons, 1st Edition, 2007.

REFERENCE BOOKS

1. Radhashyam Rai, "Smart Materials for Smart Living", Nova Publishers, USA, 2017.
2. Qun Wang (Ed.), "Smart Materials for Tissue Engineering", RSC, UK, 2017.
3. Johannes Michael Sinapius, Adaptronics – "Smart Structures and Materials", Springer, 2020.
4. Anca Filimon (Ed.), "Smart Materials": Integrated Design, Engineering Approaches and Potential Applications, CRC Press, 2019.
5. Vijay K. Varadan, "Smart material systems and MEMS: design and development methodologies", John Wiley & Sons, 2006.
6. Seung- Bok Choi & Young-Min Han, "Piezoelectric actuators: control applications of smart materials", CRC Press - 2010.
7. Kwang J. Kim & S. Tadokoro, "Electroactive polymers for robotics applications: artificial muscles and sensors", Springer, 2007

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology
2. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/122/102/122102008/

<table>
<tr><td>Course Title</td><td colspan="3">Flow Analysis Using Ansys Fluent</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ER0504</td><td>Credits</td><td colspan="2">2</td><td colspan="2">Class</td><td colspan="2">V Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>2</td><td>3</td><td>3</td><td>13</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

This course provides practical knowledge related to Ansys-Fluent and demonstrates the concept for real-time applications in Mechanical engineering domain. It is intended to cater to the needs of budding mechanical engineers in fluid flow applications. Ansys-Fluent uses numerical analysis and algorithms to solve and analyse problems of fluid flow and focuses on research culture in Fluid kinematics and dynamics.

COURSE OBJECTIVES

1. To provide the knowledge to understand the basics of Ansys-fluent.
2. To analyse the fluid flow over a flat plate and through the circular pipe.
3. To provide knowledge for fluid flow over the immersed bodies using Ansys-Fluent.
4. To analyse the Aerodynamic properties for various geometries.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Apply the computational fluid dynamic fundamentals by using advanced solvers.	1,2,5	1,2
CO2	Analyse the flow of fluid over a flat plate, through circular pipe and document the results in the form of technical report.	1,2,3,5,9,10	1,2,3

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO3	Analyze the flow measuring devices and document the results in the form of technical report.	1,2,3,5,9,10	1,2,3
CO4	Investigate the behavior of flow around different structured objects and document the results in the form of technical report.	1,2,3,5,9,10	1,2,3
CO5	Validate the Aerodynamic properties for flow over cylinder and document the results in the form of technical report.	1,2,3,5,9,10	1,2,3
CO6	Estimate the Aerodynamic properties for flow over Symmetrical Aero foil and document the results in the form of technical report.	1,2,3,5,9,10	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3				✓		
CO4				✓		
CO5				✓		
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			1				1	1			2	1	
CO2	3	3	1		1				1	1			2	1	1
CO3	3	3	1		1				1	1			2	1	1
CO4	3	3	1		1				1	1			2	1	1
CO5	3	3	1		1				1	1			2	1	1
CO6	3	3	1		1				1	1			2	1	1
Average	**3**	**2.83**	**1**		**1**				**1**	**1**			**2**	**1**	**1**

Note: 1-Low, 2-Medium, 3-High

Theory

Basics of Computational Fluid Dynamics

Fluid properties, Types of Fluid flow, Introduction to CFD, Capabilities of CFD, Discussion on Governing Equations for Fluid Dynamics, Models of the Flow- Basic discretization method, Finite Control Volume, Initial and Boundary conditions, Discussion on Turbulent fluid flow models and Basics of Ansys Fluent- Preprocessor, Processor, and post processor.

Practice

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1	Analysis of Flow over a flat plate	Ansys-Fluent	Hands on Experience
2	Analysis of Flow through circular pipe	Ansys-Fluent	Hands on Experience
3	Analysis of Flow Measuring devices (Venturi meter and orifice meter)	Ansys-Fluent	Hands on Experience
4	Estimation of minor losses in flow domain in a circular pipe	Ansys-Fluent	Hands on Experience

5	Analysis of Notches	Ansys-Fluent	Hands on Experience
6	Flow over a cylinder	Ansys-Fluent	Hands on Experience
7	Flow over a symmetrical Aero foil	Ansys-Fluent	Hands on Experience

TEXT BOOKS

1. Suhas V Patankar, "Numerical Heat Transfer and Fluid Flow", CRC Press, 1st Edition, 2018.

REFERENCE BOOKS

1. Norman Rhodes, "Computational Fluid Dynamics in Practice", Wiley, 1st Edition, 2001.
2. Jhon D Anderson, "Fundamental of Computational fluid dynamics", McGraw-Hill Publications, 6th Edition, 1995

JOURNALS/MAGAZINES

1. International Journal of Computational Fluid Dynamics, Taylor and Francis.
2. Progress in Computational Fluid Dynamics, An International Journal, Inderscience Publishers.

SWAYAM/NPTEL/MOOCs:

1. Computational Fluid Dynamics, by Prof. Suman Chakraborty, IIT Kharagpur (https://onlinecourses.nptel.ac.in/noc21_me126/preview)
2. Foundation of Computational Fluid Dynamics, by Prof. Vengadesan, IIT Madras (https://onlinecourses.nptel.ac.in/noc20_me64/preview)

Course Title	**Fluid Machines Lab**				**Course Type**		**Hard Core**	
Course Code	**B20ER0505**	**Credits**	**1**		**Class**		**V Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Fluid Machines Lab is focused on the applications of theoretical concept learned from the Fluid mechanics and machines course. The students will be conducting experiments in the laboratory pertaining to determination of losses of fluid flow through pipe, calibration of flow measuring devices, performance testing of Hydraulic turbines, Centrifugal Pumps, blowers and Reciprocating pumps.

COURSE OBJECTIVES

1. The course will impart practical knowledge in verification of principles of fluid flow.
2. To introduce various fluid flow measuring devices and determine discharge.
3. To introduce the experimental procedure in conducting the performance testing of various fluid machineries.
4. To understand the performance characteristics of various fluid machineries.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the properties of fluids.	1	1
CO2	Determine the energy losses for fluid flow through pipe and its fittings and document the results in the form of technical report.	1,2,3,9,10	1,2,3
CO3	Determine the discharge for fluid flow through pipes and open channel and document the results in the form of technical report	1,2,3,9,10	1,2,3

CO4	Compute the coefficient of impact for jet striking the vanes and document the results in the form of technical report.	1,2,3,9,10	1,2,3
CO5	Conduct experiments, interpret the data, analyze the Centrifugal and reciprocating power absorbing machines and document the results in the form of technical report.	1,2,3,9,10	1,2,3
CO6	Conduct experiments, interpret the data, analyze the hydraulic power generating machines and document the results in the form of technical report.	1,2,3,9,10	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓			
CO3			✓			
CO4			✓			
CO5				✓		
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									1			2		
CO2	3	2	1						3	2			3	2	1
CO3	3	2	1						3	2			3	2	1
CO4	3	2	1						3	2			3	2	1
CO5	3	3	1						3	3			3	2	1
CO6	3	3	1						3	3			3	2	1
Average	**3**	**2.4**	**1**						**3**	**2.2**			**2.8**	**2**	**1**

Note: 1-Low, 2-Medium, 3-High

Part-A

1. Determination of friction factor and Reynold's number for the fluid flowing through pipes.
2. Determination of minor losses for fluid flow through pipe fittings.
3. Calibration of Veturimeter, Orifice meter, flow nozzle and V notch.
4. Determination of force developed by impact of jets on vanes.

Part-B

1. Performance test on Single stage Centrifugal pump to draw Main and Operating characteristic curves.
2. Performance test on Multi- stage Centrifugal pump to draw Main and Operating characteristic curves.
3. Performance test on Reciprocating pump to draw Main and Operating characteristic curves.
4. Performance test on two stage Reciprocating air compressor.
5. Performance test on Centrifugal air blower.
6. Performance test on Pelton turbine to draw Main and Operating characteristic curves.
7. Performance test on Francis turbine to draw Main and Operating characteristic curves.
8. Performance test on Kaplan turbine to draw Main and Operating characteristic curves.

TEXT BOOKS

1. Dr. Bansal, "Fluid Mechanics and Machinery", R.K.Lakshmi Publications, 2018.
2. Jagadish Lal, "Fluid Mechanics and Hydraulic", Metropolitan Book Company, 4th edition 2012.

REFERENCE BOOKS

1. Yunus A. Cengel and John M.Cimbala, "Fluid Mechanics (SI Units)", 4th edition, Tata McGraw Hill, 2019.
2. Pijush.K.Kundu, "Fluid Mechanics", Taylor & Francis, 3rd edition, 2015.

JOURNALS/MAGAZINES:

1. https://www.cambridge.org/core/journals/journal-of-fluid-mechanics

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc22_me31/preview
2. https://www.my-mooc.com/en/categorie/mechanical-engineering

Course Title	Heat Engine Lab				Course Type		Hard Core	
Course Code	B20ER0506	Credits	1		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with the conduction of experiments to find the various properties of fuel such as Flash point, Fire point, Calorific value, Viscosity and these properties are essential to find the substitute fuel for IC engine. This course also deals with evaluation of performance parameters of IC Engines and enable the students to have hands on experience to conduct performance test on IC engines. Also describes the method of determining the area of regular and irregular geometry by using planimeter. The practical work enables the students to gain expertise and become familiar automobile sector.

COURSE OBJECTIVES

1. This course will provide a basic understanding of fuel properties and its measurements using various types of measuring devices
2. To determine area of regular and irregular geometrical figures
3. Energy conversion principles, analysis and understanding of I C Engines will be discussed. Application of these concepts for these machines will be demonstrated.
4. Performance analysis will be carried out using characteristic curves
5. To give students hands on practice to evaluate performance of petrol and diesel engines.
6. To know the various heat losses by drawing heat balance sheet.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Evaluate the flash and fire point of the given petroleum products by using suitable apparatus and suggest the suitable lubricant for stated engine conditions.	1,2,9	1
CO2	Calculate the area of regular and irregular geometrical surfaces.	1,9	1
CO3	Compare calorific value of the fuels and estimate the amount of energy content.	1,2, 9	1,2
CO4	Draw and interpret the valve timing diagram of four stroke engine.	1,9	1,2,3
CO5	Evaluate the frictional power in a multi cylinder engine by Morse test.	1,2,9	1,2,3
CO6	Conduct experiments, interpret and analyze the result of IC engine performance and document the results in the form of technical report.	1,2,4, 9,10	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2		✓				
CO3				✓		
CO4				✓		
CO5				✓		
CO6					✓	

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1							1				1		
CO2	2								1				2	1	
CO3	3	2							1				2	1	
CO4	3								3				2	1	1
CO5	3	3							3				2	1	1
CO6	3	2		1					3	3			2	2	1
Average	**2.6**	**2**		**1**					**2**	**3**			**1.8**	**1.2**	**1**

Note: 1-Low, 2-Medium, 3-High

Part-A

1. Determination of area of regular and irregular surface Using Planimeter.
2. Draw the Valve timing diagram of four stroke diesel engine.
3. Determination of Viscosity of a lubricating oil using Redwoods, Saybolt and Torsion Viscometers.
4. Determination of Calorific value of gaseous fuels.
5. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.

Part-B

Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio heat balance sheet for the engines.

a. Four stroke diesel Engine
b. Four stroke petrol Engine
c. Multi cylinder petrol Engine (Morse test)
d. Two stroke petrol engine
e. Variable compression ratio I.C. Engine.

TEXT BOOK

1. P.K. Nag "Engineering Thermodynamics" Tata McGraw Hill, 6th Edition 2018.

REFERENCE BOOKS

1. R.B.Mathur and R.P.Sharma, Internal Combustion Engines., Dhanpat Rai publication, 2002.
2. Yunus A. Cenegal and Michael A. Boles, "Thermodynamics -An Engineering Approach", Tata McGraw-Hill publication, 2002.
3. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill, Prentice-hall of India Pvt. Ltd.

JOURNALS/MAGAZINES

1. International Journal of Heat and Mass Transfer
2. American Institute of Aeronautics and Astronautics

SWAYAM/NPTEL/MOOCs

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

1. https://www.coursera.org/browse/physical-science-and-engineering/mechanical-engineering
2. https://www.my-mooc.com/en/categorie/mechanical-engineering
3. https://nptel.ac.in/cours

Course Title	Indian Traditions and Culture				Course Type		FC	
Course Code	B20PA0501	Credits	1		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**1**	**1**	**13**	**0**	**50 %**	**50 %**

COURSE OBJECTIVES

1. Provide conceptual knowledge of Indian culture and traditions
2 .Introduce students to the science and technological advancements related to Indian culture
3. Help students understand the Indian spiritual aspects of Indian culture
4. Help learners understand the factors which unite the diverse cultures of India

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Gain conceptual understanding of Indian culture and traditions.	8,9,10	
CO2	Describe various ancient theories in treatment of any disease.	8,9,10	
CO3	Appreciate the science and technological advancements in ancient India.	8,9,10	
CO4	Comprehend the Indian spiritual aspects of Indian culture like yoga, meditation and nirvana.	8,9,10	
CO5	Demonstrate the theory behind celebrating Hindu festivals and concept of making varieties of food	8,9,10	
CO6	Understand India as a land united by cultural diversity.	8,9,10	

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√				
CO2	√	√				
CO3	√	√				
CO4	√	√				
CO5	√	√				
CO6	√	√				

COURSE ARTICULATION MATRIX

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1								2	2	2					
CO2								2	2	2					
CO3								2	2	2					
CO4								2	2	2					
CO5								2	2	2					

CO6								2	2	2					
Average								**2**	**2**	**2**					

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Indian Tradition

Culture: Indus Valley Civilization and early cultural practices, The Vedic culture, Influence of Buddhism and Jainism on Indian Culture, Influence of Islam and Christianity, Indian Cultural Renaissance of the 19th Century

Religion: Pre-vedic and Vedic religion, Jainism, Buddhism, Hinduism, Religious Reform Movements, Advent of Christianity

Art: Introduction to Natyashastra, classical and contemporary art forms (dance and music), regional art forms (dance and music), Folk art, puppetry

Architecture: – Engineering and Architecture in Ancient India, Evolution of Hindu Temple Structures, Sculptures, Coins and Pottery from Ancient India v. Literature- Vedas, Upanishads, Ramayana, Mahabharata & Bhagavat Gita.

Unit-2

Contribution of ancient India to Science and Maths

Development of Science in Ancient India: Astronomy, Mathematics, Medicine, Metallurgy.

Scientists of Ancient India: Mathematics and Astronomy- Baudhayan, Aryabhata, Brahmagupta, Bhaskaracharya, Mahaviracharya. Science- Kanad, Varahamihira, Nagarjuna. Medical Sciences (Ayurveda and Yoga) - Susruta, Charaka, Yoga and Patanjali

Science and Scientists in Medieval India: Mathematics, Biology, Chemistry, Astronomy, Medicine, Agriculture.

Scientists in Modern India: Srinivas Ramanujan, Chandrasekhara V Raman, Jagadish Chandra Bose, Homi Jehangir Bhabha, Dr,Vikram Ambalal Sarabhai, ,Dr. APJ Abdul Kalam.

Unit-3

Indian Spiritual Aspects

Hindu Spirituality Based on Shruti and Smriti: Hinduism in General, Basic notions of Vedas, Upanishads, Ramayana, Mahabharata and Bhagavat Gita.

Hata Yoga and Pranayama: Main Features, Basics of Yoga –Different kinds of Yoga; Raja Yoga (Ashtanga yoga); Karma yoga;

Bhakti Yoga: Yoga of Loving Devotion; Jnana yoga – Yoga of Knowledge; Hatha Yoga (Asana/ Pranayamas); Kundalini Yoga; Nada Yoga; Sannyasa Yoga

Buddhist, Jaina Spiritualities: Main Doctrines of Buddhism: Four Noble Truths (Arya Satya), Concept of Nirvana - Ashtanga Marga.

Unit-4

Unity in Diversity

Commensality and the Significance of Food: Eating Together as Family and as a Society, Food at Rituals, annaprasan, marriage and funeral, Kitchen as Shared Space for Women, Food and Nationalist Response of Indian Community, Visibility of Indian Cuisine in the World

Celebrating Diverse Festivals: Festival Types: Religious and Seasonal, Religious - Holi, Diwali, Ganesh Chaturthi, Janmashtami, Mahavir Jayanthi, Ramadan, Christmas, Buddha Purnima; Seasonal (harvest festivals) - Baisakhi, Pongal, Sankranti

Attire: Indus Valley Civilization, Vedic period, Modern India.

TEXT BOOKS

1. Sundararajan K.R., “Hindu Spirituality - Vedas through Vedanta, Cross Road Publications”, New York, 1997.
2. Griffiths Bede, “Yoga and the Jesus Prayer Tradition, Asian Trading Corporation”, Bangalore, 1992
3. Ansh Mishra, Science in Ancient India, Indian Corporation, New Delhi, 1998

4. Sen Taylor, Collen. Feasts and Fasts: A History of Food in India. Reaktion Books, New Delhi, 2014.
5. Thapar, Romila, Readings in Early Indian History. Oxford University Press. New Delhi, 2018

6th Semester

Course Title	Heat Transfer				Course Type		Hard Core	
Course Code	B20ER0601	Credits	3		Class		VI semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	0	0	0	Theory	Tutorial	IA	SEE
	Tutorial	1	2	2				
	Total	**3**	**4**	**4**	**26**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Heat Transfer is the study of the modes of heat transfer and the laws governing the modes of Heat Transfer. It provides the knowledge on insulation for various thermal applications. Application of concept of heat transfer for applications in the field of Heat Exchanger design and phase change phenomenon.

COURSE OBJECTIVES

1. To introduce the basic modes of heat transfer and their governing equations.
2. To identify the combined heat transfer processes for steady and unsteady state.
3. To analyze conduction, convention and radiation problems.
4. To design heat exchangers and analyze boiling and condensation process.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the three modes of heat transfer and their governing equations.	1	1
CO2	Analyse the combined mode of heat transfer through composite walls and fins.	1,2	1,2
CO3	Apply Lumped system and Heisler chart analysis to interpret transient heat conduction phenomenon.	1,2,3,5	1,2
CO4	Identify and apply the appropriate method to solve heat transfer problems.	1,2	1,2
CO5	Design heat exchangers using LMTD and Effectiveness-NTU method.	1,2,3,5	1,2
CO6	Analyse the phase change convective process during boiling and condensation process.	1,2	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3			✓			
CO4		✓				
CO5			✓			
CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	2											1	2	
CO3	3	3	2		1								2	1	

CO4	3	2											1	1	
CO5	3	2	2		1								1	1	
CO6	2	3											1		
Average	**2.8**	**2.4**	**2**		**1**								**1.5**	**1.25**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction to Heat transfer: Modes and Basic governing laws of heat transfer, Boundary conditions, Thermal contact resistance, Overall heat transfer coefficient, 3-D heat conduction equation in Cartesian co-ordinates, Discussion on 3-D conduction equation in Cylindrical & Spherical coordinates, 1-D steady state heat conduction without heat generation (plane wall, cylinders & spheres), Thermal Resistances in Series and in Parallel, Numerical.

Conductive Heat transfer: Critical thickness of insulation on spheres and cylinders, Introduction to fins, Discussion on governing equations for different conditions of fins, effectiveness & efficiency of fin, Numerical.

Unit-2

1-D Transient Conduction: Lumped system Analysis, Use of Heisler's charts for transient conduction in plane slab, long cylinder, and sphere. Numerical examples, Introduction to Numerical analysis of Heat conduction

Natural Convection: Hydrodynamic and thermal boundary layer over a flat plate and Flow through duct, critical Reynolds number, Application of dimensional analysis for free convection, Numerical.

Unit-3

Forced Convection: Applications of dimensional analysis for forced convection, physical significance of Reynolds, Prandtl, Stanton, Nusselt numbers, Numerical on applications involved with laminar and turbulent flow.

Radiation Heat transfer: Thermal radiation, definitions of various terms, Laws of black body radiation-Stefan Boltzmann, Wein's displacement law, Kirchhoff's law, Planck's law, Black body concept, Discussion on radiation shape factor, Discussion on heat exchange between two gray bodies (Infinite parallel planes), Discussion on effect of radiation shields, Numerical.

Unit-4

Heat Exchangers: Classification, Overall heat transfer coefficient, fouling and fouling factors, LMTD, Discussion on effectiveness-NTU method of analysis of heat exchangers, Numerical.

Phase Change Convective Process: Condensation and its types, Discussion of condensation with Nusselt theory, Reynolds number for condensate flow. Boiling-types of boiling, Regimes of pool boiling, Pool boiling correlations, Numerical.

CASE STUDIES

1. Develop the python programming to understand the one dimensional heat equation and draw the temperature variation.
2. Develop the python programming for analyzing the 2D temperature distribution.
3. Development of a MATLAB Program for Transient Heat Transfer Coefficient Studies.
4. How refractory layers are organized in furnace construction and explain the conceptual design.
5. Discuss the heat transfer theory behind the design of Microwave oven and Egg boiler.

TEXT BOOKS

1. Tirumaleshwar, "Heat & Mass Transfer", Pearson Education, 2nd Edition, 2012.
2. Ozisik, "Heat transfer-A basic approach", Tata McGraw Hill, 1st Edition, 1985.

REFERENCE BOOKS

1. Yunus A-Cengel, "Heat and Mass Transfer", Tata McGraw hill, 6th Edition, 2020.
2. Mahesh M Rathore, "Heat and Mass Transfer", Laxmi publications, 3rd Edition, 2016.
3. Frank Kreith, Raj. M. Manglik, Mark. S. Bohn, "Principles of Heat Transfer", Thomas Learning, 7th Edition, 2010.
4. Frenk P.Incropera and DavidP.Dewitt, "Principles of Heat and Mass transfer", John Wiley and sons, 6th Edition, 2018.
5. R K Rajput, "A Textbook of Heat and Mass Transfer", S Chand Publications, 7th Edition, 2019.

JOURNALS/MAGAZINES

1. The Journal of Heat Transfer, ASME.
2. International Journal of Heat and Mass Transfer, Elsevier.

SWAYAM/NPTEL/MOOCs:

1. Heat Transfer, By Prof. Ganesh Viswanathan, IIT Bombay, https://onlinecourses.nptel.ac.in/noc20_ch12/preview
2. Heat Transfer, By Prof. Sunando Dasgupta, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc19_ch23/preview

Course Title	**Finite Element Methods**				**Course Type**		**Hard core**	
Course Code	**B20ER0602**	**Credits**	**3**		**Class**		**VI Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	0	0	0	Theory	Tutorial	IA	SEE
	Tutorial	1	2	2				
	Total	**3**	**4**	**4**	**26**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

The FEM course deals with the Steps involved in FEM, Selection of Elements, and analyze 1D and 2D solutions. This course covers higher Order Elements, the Hermite Shape function and 1D heat transfer problems.

COURSE OBJECTIVES

1. To enable the students to understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and heat transfer problems.
2. To provide systematic and comprehensive knowledge of the basics of the Finite element method as an analysis tool.
3. To teach the students the characteristics of various elements and the selection of suitable elements for the problems being solved.
4. To make the students derive finite element equations for simple and complex elements.
5. To make the student solve for field variable for thermal composite wall problems.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Discuss the steps involved in the Finite Element Method.	1	1,2
CO2	Select the suitable elements and apply boundary conditions for structural analysis.	1,2,3	1,2
CO3	Provide FE solutions for bars, trusses, and beam for stated structural boundary conditions.	1,2,3,5, 12	1,2,3
CO4	Develop shape functions for Higher-Order Elements by using Lagrange's interpolation Method.	1,2,3	1,2, 3
CO5	Develop and apply the Hermite Shape function to determine the deflection in beams carrying concentrated and UDL loads.	1,2, 3	1,2,3
CO6	Apply the FEM method to solve 1D heat transfer on the pin- fins and composite walls.	1,2,3,12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	**Bloom's Level**					
	Remember (L1)	**Understand (L2)**	**Apply (L3)**	**Analyze (L4)**	**Evaluate (L5)**	**Create (L6)**
CO1		✓				
CO2			✓			

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO3				✓		
CO4			✓			
CO5			✓			
CO6			✓			

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											3	2	
CO2	3	1											3	3	
CO3	3	3	2		3							1	3	2	1
CO4	3	3	2										3	3	1
CO5	3	3	2										3	2	1
CO6	3	3	3		3							1	3	3	1
Average	**3**	**2.66**	**2.2**		**3**							**1**	**3**	**2.5**	**1**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Introduction to FEM, Steps involved in FEM, Phases of FEM, Engineering applications, Advantages, Disadvantages, List of commercial FEM Packages.

Discretization: Types of elements used in FEM, Shape and behavior, Choice of element types, size and number of elements, Location of nodes, Node and Element numbering, coordinate systems, and Convergence criteria. Stiffness matrix and its properties.

Unit- 2

Interpolation polynomials: 1D Linear, quadratic and cubic. Simplex, complex, and multiplex elements. 2D PASCAL's triangle CST elements, 1D linear shape functions in NCS, and Jacobian for triangular element, numerical.

Solution of 1-D Bars: Derivation of element stiffness matrix, Numerical on bars on the uniform, stepped, and tapered cross-sections to analyze displacements, reactions and stresses by using penalty and elimination approaches.

Unit-3

Introduction: Types of trusses, Derivation of stiffness matrix, Numerical with 2 and 3 elements.

Higher Order Elements: Lagrange's interpolation, shape functions for higher order 1D elements - Quadratic and cubic element, iso-parametric, sub-parametric and super parametric elements, Shape function for linear quadrilateral element, numerical

Unit-4

Beams: Hermite shape functions for beam element, Derivation of stiffness matrix using Hermite shape functions, Numerical on beams carrying concentrated & UDL.

Heat transfer: Steady-state heat transfer, 1D heat conduction governing equation, Boundary condition, Numerical on heat conduction and convection in composite walls, and pin fins.

CASE STUDIES

1. Parametric Finite Element Analysis of Bicycle Frame Geometries
2. Truss bridge structure frame section analysis by using Finite element analysis
3. Stress Analysis of the truck chassis using Finite Element Analysis (FEA)
4. Structural dynamic analysis of storage frames**.**

TEXT BOOKS

1. S. S. Bhavikatti, "Finite Element Analysis", New Age International publishers, 3rd Edition, 2015.

2. Tirupathi. R. Chandrapatla, Ashok. D. Belegundu, “Finite Elements in Engineering”, Pearson Education India, 4th Edition, 2015.

REFERENCE BOOKS

1. J. N. Reddy, “Introduction to Finite Element Method”, McGraw Hill, 4th Edition, 2020.
2. David Hutton, “Fundamentals of Finite Element Analysis”, McGraw Hill Education, 2017.
3. Robert D. Cook, “Concepts and Applications of Finite Element Analysis”, Wiley 4th Edition, 2009

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/finite-elements-in-analysis-and-design
2. https://www.hindawi.com/journals/mpe/si/632341/

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112104116
2. https://onlinecourses.nptel.ac.in/noc20_me91/preview

Course Title	**Design of Transmission Elements**				**Course Type**		**Hard Core**	
Course Code	**B20ER0603**	**Credits**	**3**		**Class**		**VI semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Design of transmission elements deals with the basics of design concepts Involved in curved beams, springs, clutches and brakes. It provides the students with fundamental skills of engineering, and the ability to apply the theories of science to practice. This course would help to fill the gap the knowledge at graduation and step into producing the detailed design of gears & bearings in Industries.

COURSE OBJECTIVES

1. To enable students to design important machine elements such as springs, brakes, curved beams, flexible power transmission elements such as belts and ropes.
2. To enable students to design different gears such as spur gear, helical gear and bevel gear.
3. To help students in understanding and selection of ball and roller bearings from the standard design catalogue.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Solve for stresses in curved beams and design of springs.	1,2,3,6,8	1,2
CO2	Design belt and rope drives used in mechanical power transmission.	1,2,3,6,8	1,2
CO3	Design clutches and brakes for automotive applications.	1,2,3,6,8	1,2
CO4	Design spur and helical gears subjected to static, dynamic & wear load conditions.	1,2,3,6,8	1,2
CO5	Design bevel gear for different load conditions and recommend appropriate solution.	1,2,3,6,8	1,2
CO6	Design ball and roller bearings subjected to cyclic loads and speeds.	1,2,3,6,8	1,2

BLOOM’S LEVELOF THECOURSE OUTCOMES

CO	**Bloom’s Level**					
	Remember (L1)	**Understand (L2)**	**Apply (L3)**	**Analyze (L4)**	**Evaluate (L5)**	**Create (L6)**
CO1			✓			
CO2					✓	

CO3			✓			
CO4					✓	
CO5					✓	
CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1			1		1					3	3	
CO2	2	2	3			1		1					3	3	
CO3	3	3	3			1		1					3	3	
CO4	2	3	3			1		1					3	2	
CO5	2	2	3			1		1					2	3	
CO6	2	3	1			1		1					3	3	
Average	**2.16**	**2.66**	**2.33**			**1**		**1**					**2.83**	**2.83**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Design of Belts and Ropes: Introduction to transmission systems, Selection and design of Flat & V-belts for different applications. Rope drives: selection of wire ropes.

Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps.

Unit-2

Clutches and Brakes: Design of single plate and multi plate clutch, Design of Block / Shoe brakes (Single Shoe Brake only), Band brakes - Simple Band brakes, Self-locking of brakes, Heat generation in Brakes.

Design of Springs: Types of springs - stresses in helical springs of circular section. Leaf Springs: Stresses in leaf springs and problems.

Unit-3

Design of Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load.

Design of Helical Gears: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads.

Unit-4

Design of Bevel Gears: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads.

Ball and Roller Bearings: Bearing Life, equivalent bearing load, selection of bearings, Bearings for cyclic loads and speeds.

CASE STUDIES

1. Design a spring to withstand the weight of an elevator which varies from 800N to 1200N force and operating 8 Hrs /day.
2. Design a crane hook to lift the load of 8000N from a mine of depth 800m.
3. Design a clutch for a 150 cc bike by considering all the factors into consideration.
4. Design a gear of sugarcane crusher by considering all the factors into consideration.
5. Design a bearing for front suspension of a 350 cc bike.

DESIGN DATA HAND BOOKS

1. Lingaiah K, “Machine Design Databook”, McGraw Hill Education, 2nd Edition, Vol1 & 2, 2017
2. Balaveera K Reddy and K Mahadevan, “Design Data Hand Book for Mechanical Engineers”, CBS Publisher, 4th Edition, Kindle Edition, 2018.

TEXT BOOKS

1. Richard G Budynas and J Keith Nisbett, " Shiegly's Mechanical Engineering Design", McGraw Hill Education, 11th Edition, 2020.
2. V. B. Bhandari, "Design of Machine Elements" Tata McGraw Hill Publishing Company Ltd., 3rd Edition 2017.

REFERENCE BOOKS

1. Robert L. Norton, "Machine Design- An Integrated Approach", Pearson Education, 5th Edition, 2018.
2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R, SI Contributions by A P Harsha, "Design of Machine Elements", Pearson Education, 8th Edition, 2019.
3. C S Sharma and Kamlesh Purohit, "Design of Machine Design Elements", PHI, 10th Printing, 2015.

JOURNALS/MAGAZINES

1. Clutches and Brakes: Design and Selection - 2nd Edition - William C. (routledge.com)
2. http://www.ijerd.com/paper/vol12-issue1/Version-1/G12015667.pdf

SWAYAM/NPTEL/MOOCs:

1. NPTEL: Design of Machine Elements I (Mechanical Engineering) (digimat.in)
2. Gear and Gear Unit Design: Theory and Practice - Course (nptel.ac.in)

Course Title	**Product Design by Additive Manufacturing**				**Course Type**		**Soft Core**	
Course Code	**B20EOS611**	**Credits**	**3**		**Class**		**VI Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Practical	0	0	0	Theory	Practical	**IA**	**SEE**
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50%**	**50 %**

COURSE OVERVIEW

Additive Manufacturing (AM) which is commonly known as 3D printing is a process of joining materials to make objects from 3D model data by building the model layer on layer, as opposed to subtractive manufacturing methodologies, such as traditional machining. The basic principle of AM is that a model, initially generated using a three-dimensional Computer Aided Design (3D CAD) system, can be fabricated directly. AM technologies have significantly evolved over the last decade because of their potential to extensively transform the nature of manufacturing processes, e.g., by enabling "Freedom of Design" in several industries are attracted by these technologies. Using AM, manufacturing of highly complex parts can be an economically viable alternative to convention al manufacturing technologies.

COURSE OBJECTIVES

Additive Manufacturing (AM) is an economically viable alternative to conventional manufacturing technologies for producing highly complex parts. The main objective of this course is to acquaint students with the concept of AM, various AM technologies, selection of materials for AM, basics of Design for Additive Manufacturing, and their applications in various fields. The course will also cover AM process plan including building strategies and post-processing

COURSE OUTCOMES (COs)

On successful completion of this course; the student shall be able to:

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Apply the fundamental knowledge of the working principles and process parameters of additive manufacturing processes to manufacture the components.	1	1,2,3
CO2	Identify, compare and contrast alternative solution processes to select the best process of additive manufacturing processes and suggest suitable methods for building a component.	1,2, 3	1,2,3

CO3	Generate information through appropriate tests to improve or revise the design of suitable post processing operation based on product repair requirement.	1,2, 3, 4	1,2,3
CO4	Recognize the need of analysis to good problem definition of **a** development of working model using additive manufacturing Processes.	1, 2, 3	1,2,3
CO5	Establish a relationship between measured data and underlying physical principles to Identify the need of design for additive manufacturing.	1, 5	1,2,3
CO6	Examine the relevant methods and techniques to Identify design constraints and choose a metal additive manufacturing process.	1, 3, 5	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2			✓			
CO3			✓			
CO4			✓			
CO5			✓			
CO6			✓			

COURSE ARTICULATION MATRIX

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												1	2	1
CO2	2	1	3										1	2	1
CO3	2	1	2	1									1	2	1
CO4	3	1	1										1	2	1
CO5	1				1								1	2	1
CO6	3		2		1								1	2	1
Average	**2.2**	**1**	**2**	**1**	**1**								**1**	**2**	**1**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

UNIT – 1

Introduction to Additive Manufacturing: Introduction to Powder Metallurgy, Reverse engineering, Different AM processes and relevant process physics, AM process chain, Application level: Direct processes – Rapid Prototyping, Rapid Tooling. Rapid Manufacturing; Indirect Processes - Indirect Prototyping. Indirect Tooling, Indirect Manufacturing.

Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.

UNIT – 2

Materials Science for Additive Manufacturing: Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship, Grain structure and microstructure

Post Processing of Additive Manufacturing Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques,

UNIT – 3

Additive Manufacturing Technologies: Powder-based AM processes involving sintering and melting (selective

laser sintering, shaping, and electron beam melting involvement).

Directed Energy Deposition Processes: Process Description, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes.

Sheet Lamination Processes: Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

Wire Arc Additive Manufacturing: Process, parameters, applications, advantages and disadvantages, case studies.

UNIT – 4

Introduction to Design for Additive Manufacturing: Introduction to geometric modelling, Modelling of Synthetic curves like Hermite, Bezier and B-spline, Parametric Representation of freeform surfaces, Design freedom with AM, Need for Design for Additive Manufacturing (DFAM), CAD tools vs. DFAM tools, Requirements of DFAM methods, General Guidelines for DFAM, The Economics of Additive Manufacturing, Design to Minimize Print Time, Design to Minimize Post-processing

Design for Metal Additive Manufacturing: Powder Morphology, Powder Size Distribution, Material Characteristics, Designing to Minimize Stress concentrations, Residual Stress, Overhangs, shrinkage, warpage and Support Material, Design Guidelines for Wall Thickness, Clearance Between Moving Parts, Vertical Slots, Circular Holes, fillets, channels, vertical Bosses, circular pins, External Screw Threads and part positioning.

TEXT BOOKS

1. Ian Gibson, David W. Rosen and Brent Stucker, “Additive manufacturing technologies: rapid prototyping to direct digital manufacturing”, Springer, 2010.
2. C.K. Chua, K.F. Leong and C.S. Lim, “Rapid prototyping: Principles and applications, 3rd Edition”, World Scientific, 2010.
3. Diegel, Olaf, Axel Nordin, and Damien Motte “A Practical Guide to Design for Additive Manufacturing”, Springer, 2020.
4. Redwood, Ben, Filemon Schoffer, and Brian Garret “The 3D Printing Handbook: Technologies, Design and Applications”, 3D Hubs, 2017.

REFERENCE BOOKS

1. Patri K. Venuvinod and Weiyin Ma,”Rapid Prototyping: Laser-based and Other Technologies”, Springer, 2004.
2. D.T. Pham and S.S. Dimov, “Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling”, Springer 2001.
3. Rafiq Noorani, “Rapid Prototyping: Principles and Applications in Manufacturing”, John Wiley & Sons, 2006.
4. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing, CRC Press, Second Edition, 2020.
5. C.P Paul and A.N Junoop, “Additive Manufacturing: Principles, Technologies and Applications”, Mc Graw Hill, 2021.
6. Laroux K and Gillespie, “Design for Advanced Manufacturing: Technologies and Process”, Mc Graw Hill, 2017.

<table>
<tr><td>Course Title</td><td colspan="3">Design for Manufacturing and Assembly</td><td colspan="2">Course Type</td><td colspan="2">Soft core</td></tr>
<tr><td>Course Code</td><td>B20ERS612</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VI semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Design for manufacturing and assembly course deals with introduction to DFMA and selection of materials product design for manual assembly and also covers design for high speed automatic assembly, robot assembly. The course covers the DFMA, CAD and TRIZ.

COURSE OBJECTIVES

1. To enable the students to understand general design principles for manufacturability, strength and mechanical factors, mechanisms selection.
2. To provide systematic basic knowledge for working principle, material, manufacture, design possible solutions and materials choice.
3. To enable the students to understand the design features to facilitate machining-drills, milling cutters, keyways, doweling procedures.
4. To formulate the identification of uneconomical design.
5. To design for economy, design for clamp-ability, design for accessibility and modifying the design.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the importance of DFMA and its impact on industry in product design and material selection.	1,2,5	1,2
CO2	Apply the DFMA design guidelines for economical design and ease of manual assembly.	1,2,5	1,2
CO3	Implement DFMA in the design of high speed automatic and robot assembly.	1,2,5	1,2
CO4	Design of parts for feeding and orienting as per DFMA guidelines for accessibility.	1,2,3,5	1,2
CO5	Integrate CAD and DFMA and understanding its effect.	1,2,5	1,2
CO6	Discuss TRIZ and its relevance in industry.	1	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2			✓			
CO3			✓			
CO4			✓			
CO5			✓			
CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			1								3	2	
CO2	3	3			1								3	3	
CO3	3	3			1								3	2	
CO4	3	2	1		1								3	3	
CO5	3	3			1								3	3	
CO6	3												3	2	
Average	**3**	**2.3**	**1.0**		**1.0**								**3**	**2.5**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction to DFMA and Selection of Materials: Meaning of design for manufacture and assembly, how DFMA works, advantages of applying DFMA in product design, typical DFMA case studies, overall impact of DFMA on industry, general requirements for early materials and process selection, selection of manufacturing processes, process capabilities, selection of materials, primary process/material selection.

Unit-2

Product Design for Manual Assembly: Introduction, General design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, effect of part symmetry, thickness, weight on handling time, effects of combinations of factors, effect of chamfer design on insertion operations, avoiding jams during assembly, application of the DFA methodology, types of manual assembly methods, assembly quality.

Unit-3

Design for High speed Automatic Assembly and Robot Assembly: Introduction, Design of Parts for High-Speed Feeding and Orienting– Example, Additional Feeding Difficulties, High-Speed Automatic Insertion, Analysis of an Assembly, General Rules for Product Design for Automation, Design of Parts for Feeding and Orienting, Product Design for Robot Assembly.

Unit- 4

Linking DFM with CAD and Introduction to TRIZ: Introduction: General Considerations for Linking CAD and DFMA, Geometric Representation Schemes in CAD Systems, Design Process in a Linked CAD/DFMA Environment, Expert Design and Cost Estimating Procedures, Introduction to TRIZ.

CASE STUDIES

1. Develop the dimensions with limits required for the components assembled together in their working condition of the Carrier Wheel Assembly.
2. Develop the dimensions with limits required for the components assembled together in their working condition of the Automobile Steering Box Assembly.
3. Develop the dimensions with limits required for the components assembled together in their working condition of the Plate Block Assembly.

TEXT BOOKS

1. George E, Dieter,"Engineering Design - Material & Processing Approach", McGraw-Hill, 2nd Edition, 2015.
2. Geoffrey Boothroyd, "Hand Book of Product Design", Marcel and Dekken, 1st Edition, 2013.

REFERENCE BOOKS

1. Geoffrey Boothroyd, "Hand Book of Product Design", Marcel and Dekken, 1st Edition, 2013.
2. Geoffrey Boothroyd, Peter Dewhurst, Winston, "Product Design for Manufacturing and Assembly", CRC Press, 1st Edition, 2014.

<table>
<tr><td>Course Title</td><td colspan="4">Turbomachines</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ERS613</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VI semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Turbomachines are rotary machines that fall under the categories of mechanical work producing machines or work absorbing machines. Machines like hydro turbines, steam turbines, gas turbines are mechanical work producing machines. Air compressors, hydraulics and other fluid pumps are work absorbing machines. The course on turbo machinery deals with terminologies, classification, principles and efficiency of energy conversion in power generating or absorbing machines.

COURSE OBJECTIVES

1. To introduce working principles, classification of turbo machines.
2. To define dimensionless parameters for a generalized fluid flow through turbo machines.
3. To derive Euler Turbine equation, degree of reaction and utilization factor of axial flow, radial flow and mixed flow

   Turbomachines.
4. To derive equations for work done, power developed and efficiencies of impulse and reaction steam turbines.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Introduce the concepts of turbomachines and compare with positive displacement machines.	1,2	1,2
CO2	Apply the concepts of dimensional analysis to formulate mathematical models of turbomachines.	1,2,3,5	1,2
CO3	Evaluate work done, power developed and efficiencies of axial and radial flow turbo machines.	1,2	1,2
CO4	Analyse the performance of 50% reaction power generating turbomachines.	1,2	1,2
CO5	Compute the performance parameters of axial flow and radial flow power absorbing turbomachines.	1,2,3	1,2
CO6	Interpret the velocity triangles and estimate the forces, power developed, and blade efficiency of Impulse and reaction steam turbines.	1,2,3	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓			
CO3			✓			
CO4			✓			
CO5			✓			
CO6			✓			

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											2	1	
CO2	3	2	1		1								2	1	
CO3	3	3											2	1	
CO4	3	3											2	1	
CO5	3	3	1										2	1	
CO6	3	3	1										2	1	
Average	**3**	**2.5**	**1**		**1**								**2**	**1**	

Note: 1-Low, 2-Medium, 3-High

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

COURSE CONTENT

Unit-1

Introduction to Turbomachines: Definition of a Turbo machine; parts of a Turbo machine, Classification, Comparison with positive displacement machine, Dimensionless parameters and their physical significance; Specific speed; Unit and specific quantities, model studies, Numerical.

Unit-2

Fundamentals of Energy Conversion in Turbomachines: Euler's turbine equation and its alternate forms, Components of energy transfer, General expression of degree of reaction, Relation between degree of reaction and utilization factor, Construction of velocity triangles for different values of degree of reaction for axial flow turbines, Numerical.

Energy Transfer in Turbomachines: Velocity diagrams and Condition for Maximum Utilization factor in axial flow Impulse and 50% reaction machines, Numerical.

Unit-3

Axial Flow Power Absorbing Turbo Machines: General analysis of axial flow Compressors, velocity triangles and general expression for degree of reaction, Numerical.

Radial Flow Power Absorbing Turbomachines: General analysis of Centrifugal flow Compressors and pumps , velocity triangles and general expression for degree of reaction , Theoretical head – capacity relationship, Types of centrifugal pump impeller, Numerical.

Unit-4

Impulse Steam turbines: Classification, Need and methods of compounding, single stage impulse turbine, condition for maximum blade efficiency, Numerical.

Reaction Steam turbines: Parsons's steam turbine, condition for maximum utilization factor, Numerical.

CASE STUDIES:

1. Prepare a report on any Compressors/Pumps/Blowers used in industry by mentioning following details: Make and specifications, operating conditions, construction, working principle, and applications.
2. Prepare a report on any Thermal power station by mentioning the following details: Make and
3. Specifications, type and of number of turbines, capacity of power generation, working principle, operating conditions and applications.
4. Prepare a report on applications of Steam turbines by literature survey.

TEXT BOOKS

1. Kadambi and Manohar Prasad, "An Introduction to Energy Conversion, Volume III, Turbo machinery", New Age International Publishers, 2nd Edition, 2013,

2. S. M. Yahya," Turbines, Compressors & Fans", Tata McGraw Hill Co. Ltd., 4th Edition, 2002.

REFERENCE BOOKS

1. D. G. Shepherd, "Principals of Turbomachines", The Macmillan Company, 2nd Edition, 2002.

2. S. L. Dixon, "Fluid Mechanics & Thermodynamics of Turbomachines", Elsevier, 7th Edition, 2014.

3. B.K.Venkanna "Fundamentals of Turbomachinery", PHI New Delhi, 2nd Edition, 2013.

JOURNALS/MAGAZINES

1. https://www.researchgate.net/topic/Steam-Turbine/publications
2. https://www.sciencedirect.com/topics/engineering/steam-turbines

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc22_me31/preview

Course Title	Electric and Hybrid Vehicles				Course Type	Soft Core
Course Code	B20ERS614	Credits	3		Class	VI semester
Course	TLP	Credits	Contact	Work	Total Number of	Assessment in

Structure			Hours	Load	Classes Per Semester		Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course is targeting students who wish to pursue research & development in industries or higher studies in the field of Electric and Hybrid Vehicles and upcoming market for retrofit of existing IC engine vehicles with electric motors. It also offers in depth knowledge about working of an Electric Vehicle by covering study of Vehicle fundamentals of EVs and its various components. The course gives an introductory level knowledge on working fundamentals of different electric motors, motor controllers, control techniques, electric vehicle drive train, regenerative braking and different types of hybrid vehicles.

COURSE OBJECTIVES

1. To provide the students with sufficient knowledge on series, parallel and complex hybrid architectures of automobile vehicles.
2. To enable the students to understand the concept of electric drive trains, hybrid architectures and hybrid power plant specifications.
3. To help the students to understand the concept of sizing the drive system, energy storage and their alternatives, energy management and control system.
4. To provide the knowledge of the various hybrid and load tracking architectures with knowledge on Hybrid power plant specifications.
5. To impart knowledge on various energy management and control strategies, energy storage systems like batteries and alternate energy storage systems like fuel cells.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the systems of electric vehicles, hybrid electric vehicles and their relevance to society and environment.	1,6,7	1
CO2	Recognize different configurations of power trains used in hybrid vehicles and identify the hybrid load tracking architectures.	1	1
CO3	Illustrate the working of different types of electrical machines, motors and drive topologies.	1	1
CO4	Demonstrate the electric propulsion unit and Identify the communication protocols and technologies used in vehicle networks.	1	1
CO5	Analyze performance of battery based energy storage and problems associated with battery systems used in electric hybrid vehicles.	1, 2	1
CO6	Describe the characteristics of fuel cell technology.	1	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3			✓			
CO4			✓			
CO5		✓				

CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3					2	2						2		
CO2	3												3		
CO3	3												2		
CO4	3												3		
CO5	3	1											2		
CO6	2												3		
Average	2.8	1				2	2						2.5		

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Sustainable Transportation, A Brief History of EHVs, Need of EHV technology, Architectures of EHVs, social and environmental importance of hybrid and electric vehicles, Challenges and Key Technology of EHVs.

EHV Fundamentals: Basics of vehicle performance, vehicle power source characterization, transmission characteristic and mathematical models to describe vehicle performance

Unit-2

Hybrid Electric Drive-trains: Basic Architecture of Hybrid Drive Trains, Energy Savings Potential of Hybrid Drivetrains, Hybrid drive train configurations- series configuration, Parallel configurations, Series-Parallel configurations and complex configurations, power flow control in hybrid drive-train topologies

Basic Architecture of Electric Drive Trains: Electric Vehicles drive train configurations, Introduction to various electric drive-train topologies, Electric Vehicle (EV) drivetrain Alternatives Based on Drivetrain Configuration, Electric Vehicle (EV) Drivetrain Alternatives Based on Power Source Configuration.

Unit-3

Electric Propulsion unit: Electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, introduction to Permanent Magnet Motors.

Control Systems for the EHV and EVs: In vehicle networks- CAN, Energy Management Strategies: Energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

Unit-4

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery Parameters, Different types of Battery used in EHVs, Battery based energy storage and its analysis, Problems associated with battery systems in EHVs, Temperature controlling methods, advanced battery technologies.

Fuel Cells: Fuel Cell Characteristics - Fuel Cell Types – Alkaline Fuel Cell - Proton Exchange Membrane - Direct Methanol Fuel Cell - Solid Oxide Fuel Cell- Hydrogen Storage Systems- Reformers - Fuel Cell EV - Super and Ultra Capacitors -Flywheels.

CASE STUDIES

1. Advances in battery health monitoring and prognostics technologies for electric vehicle (EV) safety and mobility
2. Energy storage systems for electric vehicle applications: issues and challenges
3. Design of a hybrid electric vehicle powertrain for optimum performance parameters
4. A comprehensive review on estimation strategies used in hybrid and battery electric vehicles
5. Data-driven reinforcement learning–based real-time energy management system for plug-in hybrid electric vehicles
6. Impacts assessment of plug-in hybrid vehicles on electric utilities and regional Indian power grids

TEXT BOOKS

1. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 3rd Edition, 2021.
2. M. Ehsani, Y. Gao and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press London, 3rd Edition, 2019.
3. James Larminie, John Lowry, “Electric Vehicle Technology”, Wiley Blackwell, 2nd Edition, 2003.

REFERENCE BOOKS

1. James Larminie, John Lowry, “Electric Vehicle Technology Explained”, 3rd edition, Wiley, 2003
2. Seth Leitman, Bob Brant, “Build Your Own Electric Vehicle” McGraw-Hill, 3rd Edition, 2013.
3. Chris Mi, M A Masrur, D W Gao, “Hybrid Electric Vehicles – Principles and applications with practical perspectives”, 4th edition, Wiley, 2011
4. C.C Chan, K.T Chau, “Modern Electric Vehicle Technology”, Oxford University Press Inc., New York, 1st Edition, 2001

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/book/9780444535658/electric-and-hybrid-vehicles
2. https://www.scimagojr.com/journalsearch.php?q=11600153305&tip=sid

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/108/103/108103009/
2. https://www.edx.org/course/electric-cars-technology
3. https://www.classcentral.com/course/edx-hybrid-vehicles-10285

Course Title	**Production and Operations Management**				**Course Type**		**Soft core**	
Course Code	**B20ERS615**	**Credits**	**3**		**Class**		**VI semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course provides insight in to various fundamental aspects of production planning and forecasting techniques. It also presents various decision making techniques, aggregating and master production scheduling methods, various inventory monitoring and controlling methods are discussed. Handling dependent demand items and techniques for MRP and continuous improvement methods are included. The course contains routing methods and supply chain managements. Quantitative techniques are heavily used in analyzing operations and improving their efficiency and effectiveness. Overall objective of this course is to manage production systems in a better way

COURSE OBJECTIVES

1. To acquire the knowledge of production planning process and its functions
2. To study the fundamentals of Inventory management
3. To provide knowledge about MRP and ERP systems
4. To introduce the concepts of purchasing and supply chain management

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the concept of operations management and apply the decision models to solve real time problems.	1,2,3	1,2,3
CO2	Recognize the role of operations management in business functions and organizations strategic planning.	1,2,3,11	1,2,3
CO3	Formulate and analyze aggregate planning and master production schedule concepts.	1,2,11	1,2,3

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO4	Analyze inventory models for a range of operations.	1,2,11	1,2,3
CO5	Evaluate a selection of frameworks used in the design and delivery of operations using MRP and ERP	1,2,3,11	1,2,3
CO6	Summarize the concepts of routing, purchasing and SCM.	1,2,3,11	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1				✓		
CO2				✓		
CO3				✓		
CO4				✓		
CO5				✓		
CO6			✓			

COURSE ARTICULATIONMATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1										3	1	1
CO2	3	3	1								1		3	1	1
CO3	3	2									1		3	1	1
CO4	3	3									1		3	1	1
CO5	3	2	1								1		3	1	1
CO6	3	2	1								1		3	1	1
Average	3	2.3	1								1		3	1	1

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction to Process Planning, Control and Forecasting: Definitions, Objectives of production Planning and Control, Functions of production planning and control, Types of production, Organization of production planning and control.

Forecasting: Importance of forecasting, Types, principles, qualitative and quantitative methods, time series methods, Exponential smoothing, Regression methods, numerical.

Unit-2

Operations Decision: Introduction, Characteristics of decisions, framework for Decision Making, Decision methodology, Decision supports systems, Economic models-Break-even analysis in operations, numerical.

Aggregate Planning and Master Scheduling: Planning and Scheduling, Objectives of Aggregate Planning, Aggregate Planning Methods, Master Scheduling Objectives, Master Scheduling Methods, numerical.

Unit-3

Inventory Management: Definition and need, components of Inventory, inventory control. Functions of inventories, inventory costs, EOQ model, Inventory control systems, P–Systems and Q-Systems, ABC analysis, VED analysis, numerical.

MRP & ERP: Introduction to MRP & ERP, JIT inventory, MRP Logic, Capacity Management, CRP activities. Concept of continuous improvement of process, numerical.

Unit-4

Routing – Dispatching: Definition, Routing & Dispatching procedure, Route sheets, Bill of material, Factors affecting routing procedure.

Supply Chain Management: Introduction to supply chain management- Approaches to purchase and supply chain management, Bull whip effect, make or buy decision, e-Procurement, Vender development, vendor rating methods, simple numerical.

CASE STUDIES

1. Forecasting of CSP (Critical Spare Parts for an Indian Automobile Industry
2. SAP Successful story of developing ERP software in Manufacturing Industry
3. Inventory Management - "A case study at Various Manufacturing Sectors"
4. Implementation of supply chain management at various global enterprise - Honda / TVS / Motorola /Amazon / Flipkart.

TEXT BOOKS

1. Samuel Eilon, "Elements of Production Planning and Control", 1st Edition, Universal Publishing Corp., 1999.
2. Joseph Monks, "Operations Management Theory and Problems", 3rd Edition, McGraw-Hill's, 1987.

REFERENCE BOOKS

1. P Rama Murthy, "Production and Operations Management", 1st Edition, New Age, 2002
2. Baffa & Rakesh Sarin, "Modern Production / Operations Management", 8th Edition, John Wiley & Sons, 2002.
3. S.N. Chary, "Operations Management", 1st Edition, TMH, 1996
4. Pannerselvam R, "Production and Operation Management", PHI publications, 2nd Edition
5. Everett E. Adams, Ronald J. Ebert "Production and Operations Management", Prentice Hall of India Publications, Fourth Edition

JOURNALS/MAGAZINES

1. https://www.tandfonline.com/toc/tprs20/current- International journal of Production research
2. https://www.emerald.com/insight/publication/issn/0144-3577-- International journal of operation and production management

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/110107141
2. https://nptel.ac.in/courses/112107238

Course Title	Automation in Manufacturing				Course Type		Soft Core	
Course Code	B20ERS621	Credits	3		Class		VI semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course explores the production facilities, need of automation in the manufacturing sectors. It deals with different industrial control system, support system for automation in this competitive environment. This course describes about the flexibility concept for manufacturing products, group technology and inspection process through automation to provide the products with better quality.

COURSE OBJECTIVES

1. Explore the concept of automation and building blocks, Fundamentals of manufacturing.
2. Identify the manufacturing support systems to different industries.
3. Enumerate the knowledge of automated production, group technology and cellular manufacturing concept.
4. Exposure to gain knowledge about automated inspection technologies.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Infer the need of digitalization for manufacturing to achieve higher quality and productivity.	1,2	1,2
CO2	Identify and use suitable manufacturing support systems for productivity enhancement.	1	1,2
CO3	Compare and identify suitable manufacturing process like group technology or flexible manufacturing system to meet the industrial requirement.	1	1,2
CO4	Apply the knowledge of intelligent manufacturing system to manufacture the product with good quality and cost effective.	1,5	1,2
CO5	Implement the automated inspection technology for modern industry requirements.	1,5	1,2
CO6	Understand the role of PLC and SCADA in modern industrial applications.	1,5	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3		✓				
CO4			✓			
CO5		✓				
CO6		✓				

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											2	2	
CO2	2												2	2	
CO3	3												2	2	
CO4	3				2								2	2	
CO5	3				2								2	2	
CO6	3				2								2	2	
Average	2.8	2			2								2	2	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Production System Facilities, Automation definition, type and Importance of automation in the manufacturing industry, Manual labor in production system, product and production relationship, cost of manufacturing operation.

Basic Elements of an Automated System: Advanced Automation Functions & Levels of Automation, Continuous versus Discrete control, Computer Process control, Forms of Computer Process Control.

Unit-2

Manufacturing Support System: Process Planning, Computer Aided Process Planning, and Concurrent Engineering & Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean manufacturing tools and techniques and agile manufacturing and its case studies, Toyota production system.

Elements of Electro-Pneumatic: advantages over hydraulics & pneumatic control, solenoid valves, relays, factory automation sensors, electrical sensors, process automation sensors and their interfaces.

Unit-3

Group Technology and Flexible Manufacturing Systems: Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing, Flexible Manufacturing Systems (FMS) and its components, FMS Applications & Benefits, FMS Planning & Implementation Issues. Case studies.

Intelligent Manufacturing Systems: Introduction, need of intelligent manufacturing system & applications.

Unit-4

Inspection Technologies: Automated Inspection, Coordinate Measuring Machines Construction, operation & Programming, Software, Application & Benefits, Flexible Inspection System, Inspection Probes on Machine Tools, Machine Vision, Optical Inspection Techniques & Non-contact Non-Optical Inspection Technologies, Case studies on automated inspection.

Industrial Control Systems: Programmable Logic Controllers (PLC) based control system, programming languages & instruction set, ladder logic, functional blocks, structured text, and their applications with various automation examples. Human Machine Interface (HMI), Supervisory Control and Data Acquisition System (SCADA), motion controller, smart sensors, RFID technology and its application, machine vision and control applications.

Demonstration: Ladder logic programming using ISP Delta software.

CASE STUDIES

1. Study on lean manufacturing and agile manufacturing, Toyota Production System.
2. Study on Flexible Manufacturing Process, Group Technology and intelligent manufacturing.
3. Study on automated inspection techniques in different industries.

TEXT BOOKS

1. M. P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education. 5th Edition, 2019.
2. John R. Hackworth & Frederick D. Hackworth Jr, "Programmable Logic Controllers – Programming Methods and Applications", Pearson, 2011.
3. Rao, P. N., "CAD/CAM Principles and Applications", Tata McGraw Hill, New Delhi, 2nd Edition, 2010.

REFERENCE BOOKS:

1. Georges Friedmann, "The Anatomy of Work: Labor, Leisure and the Implications of Automation", Hassell Street Press, 2021.
2. Viswanandham, "Performance Modeling of Automated Manufacturing Systems", Prentice Hall India Learning Private Limited, 2015.
3. Krishna Kant, "Computer Based Industrial Control", Prentice Hall India Learning Private Limited, Revised 2nd Edition 2011.
4. Nakra, B. C., "Theory and Applications of Automatic Controls", New Age International Publishers, Revised 2nd Edition, 2014.
5. John W. Webb & Ronald A. Reis, "Programmable Logic Controllers – Principles and Applications", Pearson Education, 5th Edition, 2008.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/search?qs=automation
2. https://asmedigitalcollection.asme.org/manufacturingscience
3. https://www.industrialautomationindia.in/

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112103293
2. https://www.digimat.in/nptel/courses/video/112104288/L01.html

Course Title	Robotic Systems Kinematics				Course Type	Soft Core
Course Code	B20ERS622	Credits	3		Class	VI semester
Course	TLP	Credits	Contact	Work	Total Number of	Assessment in

Structure			Hours	Load	Classes Per Semester		Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Robots all have some kind of mechanical construction, a frame, form or shape designed to achieve a particular task. This course deals with the construction, operation, transformation, types of end effectors used, programming and industrial and non-industrial applications of robots as well as the computer-vision systems.

COURSE OBJECTIVES

1. Identify the types of industrial robots.
2. Compute the concepts of robot representation using concepts of kinematics.
3. To attain knowledge about the uses & limitation of robotic applications.
4. To describe the basic methods & algorithms used in path planning for industrial robots.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Understand the fundamentals of robotic systems and their terminologies.	1	1,2
CO2	Analyze direct kinematics of manipulator configurations.	1,2	1,2
CO3	Design manipulator configuration and end-effector for industrial applications.	1,2,3	1,2
CO4	Apply the knowledge of path planning to develop robots to perform basic operations.	1,2	1,2
CO5	Develop the part program for various robotic applications.	1,2,3	1,2
CO6	Understand the role of vision system for the robot applications.	1,2	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3			✓			
CO4		✓				
CO5			✓			
CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	1	
CO2	3	3	1										3	1	
CO3	3	2											3	1	
CO4	2	1											3	1	
CO5	3	2	1										3	1	
CO6	3	1	1										3	1	
Average	2.8	1.8	1										3	1	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Fundamental laws of Robotics, Brief History of Robotics, Classification of Robots, robot anatomy and configuration, Robot Evaluation- resolution, repeatability and accuracy of robot, Numerical.

Structure of Robots: Types of Joints, Representation of Joint, Degrees of Freedom and workspace.

Unit-2

Spatial Description: Description of position and orientation of a rigid body, Types of Frames, Euler angle representation for XYZ, XYZ frames.

Transformations: Translation, Rotation, Scaling (numerical with real applications), Homogeneous representation of Transformations, Properties of rotation matrices and combined transformations (numerical with real applications).

D-H Convention: Forward Kinematics, Implementation of D-H convention and obtaining transformation matrices for 3R Manipulator, SCARA Manipulator, PUMA 560 Manipulator. Inverse Kinematics, Inverse Kinematics of 3R Manipulator.

Demonstration: Design and simulation of different types of robot like ABB, KUKA, FANUC robots models using Robot Simulation Software.

Unit-3

Robot End Effectors: Types of end effectors, Mechanical gripper, types of mechanical grippers, magnetic gripper, Vacuum gripper, Adhesive gripper, other special grippers.

Trajectory planning: Joint space scheme, Cubic trajectory, Joint space schemes with via points, third order polynomial trajectory planning.

Case study: Robot Applications, Industrial and non-industrial application, mobile application, limitations and future application of robot.

Unit-4

Robot Programming: Methods of Programming, Lead through Programming Methods, Three levels of Robot Programming, Teach by Showing, Explicit Robot Programming Language, Task Level Programming Language. Requirements of Robot Programming Language, World Modelling, Motion Specifications, Flow of Execution. Programming Environment, Sensor Integration, AML and VAL. Simple example, programming with graphics.

Machine Vision System: Introduction to Machine vision, functional block diagram of machine vision system, Sensing and Digitizing, Image processing and analysis.

CASE STUDIES:

1. Robotics post-test processing of ABB Robot
2. How ABB Robotics reduced development time
3. ABB Robotic calibration

TEXT BOOKS

1. Saeed B. Niku, “Introduction to Robotics: Analysis, Systems, Applications”, 2nd edition, Pearson Education India, PHI, 2003.
2. Ganesh S Hegde, “Industrial Robotics”, University Science Press, Second edition, 2009.

REFERENCE BOOKS

1. M.P. Groover, “Industrial Robotics – Technology, Programming and Applications”, McGraw-Hill, USA, Second Edition, 1986.
2. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, “Machine Vision”, Tata McGraw-Hill, Second Edition 1991.
3. Yoremkoren, “Robotics for Engineers”, McGraw-Hill, USA, Second Edition 1987.
4. P.A. Janaki Raman, “Robotics and Image Processing”, Tata McGraw-Hill, Second Edition 1991.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/robotics-and-autonomous-systems
2. https://www.sciencedirect.com/journal/robotics

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_me76/preview

Course Title	Refrigeration and Air Conditioning				Course Type		Soft Core	
Course Code	B20ERS623	Credits	3		Class		VI semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course provides the knowledge on refrigeration and air conditioning system. Understand the concept of thermodynamic cycles applicable to produce cooling effect through various systems. It gives information about various components and working fluids used in various refrigeration systems. It also provides knowledge on estimation of the capacity of the plant for particular cooling application. This course enlightens the uses of refrigeration and air conditioning in various real time applications. This course provides basic knowledge to work in R&AC industries.

COURSE OBJECTIVES

1. To understand various refrigeration cycles and refrigeration systems
2. To acquire the knowledge on refrigerants and their effects and various components used in R&AC system
3. To understand principles of psychrometry and develop the skills to estimate cooling load and heating load for summer and winter air conditioning
4. To gain the knowledge on how refrigeration and air conditioning will be useful in domestic and commercial application
5. To expose the students to field of refrigeration and air conditioning, so that they can get an opportunity to work in R&AC industries.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Explain working of refrigeration and air conditioning systems.	1	1,
CO2	Summarize the application of refrigerants and working of components used in refrigeration and air-conditioning systems.	1,7	1
CO3	Evaluate the performance of vapour compression, vapour absorption and air refrigeration systems.	1,2	1,2
CO4	Design summer and winter air conditioning systems based on cooling and heating loads.	1,2,3	1,2,3
CO5	Demonstrate the knowledge on construction, working of water coolers and air conditioning systems used in food storage, automotive vehicles, hospitals and theaters.	1,2	1
CO6	Discuss cryogenic concept used for liquefaction of air and oxygen.	1	1

BLOOM'S LEVELOF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO2		✓				
CO3			✓			
CO4				✓		
CO5			✓			
CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												3		
CO2	2						1						2		
CO3	3	2											3	1	
CO4	3	3	1										3	1	1
CO5	2	2											3		
CO6	2												2		
Average	**2.3**	**2.33**	**1**				**1**						**2.6**	**1**	**1**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Refrigeration Cycles: Methods of refrigeration, Vapour compression refrigeration cycle and actual vapour compression cycle, Air refrigeration cycle, Aircraft refrigeration system- simple and boot strap system with performance analysis. Vapour absorption systems-COP of the system, simple Ammonia-water vapour absorption system with performance evaluation-actual vapour absorption system, Lithium bromide, three fluid vapour absorption systems, and simple numerical.

Unit-2

Refrigerants: Refrigerant classification, Designation, Refrigerant properties, Oil Compatibility – Environmental Impact- ozone layer depletion, global warming, Alternate refrigerants, Refrigerant absorbent combinations for vapor absorption system.

Refrigeration Components: Reciprocating Open & Hermetic type, Screw Compressors and Scroll Compressors, Condensers-types, Evaporators-types, chillers-types, Expansion devices-capillary tube- automatic expansion valve -thermostatic expansion valve- Low side-high side float, low pressure and high pressure cut outs, solenoid valves.

Unit-3

Design of Air conditioning systems: Review of Moist air properties-various psychrometric process, Summer and Winter Air-conditioning, Cooling load calculations-comfort chart-SHF-GRSHF-ERSHF, cooling load estimate, Cooling load calculation using HVAC Design software

Unit-4

Air-conditioning Systems: Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Air handling system- ducts and its arrangements, room air distribution- supply air outlets.

Application of Refrigeration and Air conditioning: Food storage, Domestic refrigerator-construction- working and maintenance, Cold storage plants, Water coolers-storage type and pressure type, Dessert cooler, Air conditioning systems for automobiles-car-bus-truck container, Air conditioning system in hospital, Air conditioning system in theaters, Introduction to cryogenics-liquefaction of air and oxygen.

CASE STUDIES

1. Cooling Load calculation of the residential house using HVAC software.
2. Study of Air conditioning system installed in hospital.
3. Study of Air conditioning system installed in theaters/auditorium.

TEXT BOOKS

1. R S Khurmi and J K Gupta, “A Text Book on “Refrigeration and Air conditioning”, S Chand Publication., New Delhi, 1st Edition, 2019.
2. W.F.Stocker and J.W.Jones “Refrigeration & Air Conditioning”, 2nd Edition, McGraw Hill Book Company, 1st Edition, 2014.

REFERENCE BOOKS

1 Manohar Prasad, “Refrigeration and Air conditioning”, 3rd Edition New Age International (P) Ltd, New Delhi,1st Edition, 2021
2. Ananthanarayanan.P.N, “Basic Refrigeration and Air Conditioning”, Tata McGraw Hill, 4th Edition, 2013
3. Roy J. Dossat,”Principles of Refrigeration”, Pearson Education Asia, 5th Edition, 2001
4. Arora, C. P., “Refrigeration and Air Conditioning”, Tata McGraw Hill, New Delhi, 4th Edition, 2021

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/international-journal-of-refrigeration
2. https://www.journals.elsevier.com/international-journal-of-refrigeration

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112105129
2. https://nptel.ac.in/courses/112105128

Course Title	Aircraft Fundamentals				Course Type		Soft Core	
Course Code	B20ERS624	Credits	3		Class		VI semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course introduces the historical evaluation of Aircraft with various configurations of aircraft, propulsion systems, and their performance analysis. The course discusses the operating principles of the aircraft engine major components. The course discusses the Aircraft Structures, materials with their instruments and principles of navigation schemes.

COURSE OBJECTIVES

1. To provide the basic knowledge on Aircraft fundamentals, early development of airplanes (space vehicles, advance propulsion and their applications)
2. To enhance the knowledge on configuration of Aircrafts (Anatomy of flight vehicles, components of an airplanes and their function lift generation, significance of L/D ratio, aerodynamic forces, pressure)
3. To enhance the Knowledge on essential features of propulsion with their aircraft structures and their materials
4. To gain the knowledge of sensing devices, data acquisition, measurements in aerodynamics, flight control and principles of navigation with atmospheric entry missions

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Acquire the knowledge on history of aircrafts and developments.	1	1
CO2	Recognize the classifications of aircraft components and their configurations.	1	1
CO3	Apply the basic concepts of propulsion systems for the study of spacecraft and aircraft performance	1	1
CO4	Interpret the different types of fuselage and their constructions.	1	1
CO5	Gain the knowledge of the different types of aircraft materials.	1	1
CO6	Analyze the different types of navigation systems and instruments for flight.	1, 2	1, 2

BLOOM’S LEVELOF THECOURSE OUTCOMES

	Bloom’s Level

CO	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓					
CO2		✓				
CO3			✓			
CO4			✓			
CO5			✓			
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												3		
CO2	2												3		
CO3	3												3		
CO4	2												3		
CO5	2												3		
CO6	3	2											3	2	
Average	**2.3**	**2**											**3**	**2**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction to Aircraft Fundamentals: History of aviation, early development of airplanes, biplanes and monoplanes, history of spaceflight, development of space vehicle, International standard atmosphere, classification of duct jet propulsion, rocket propulsion, advance propulsion and applications.

Unit-2

Configurations of Aircraft: Anatomy of flight vehicles, components of an airplanes and their functions, configuration of space vehicle, Importance of aerodynamics; Airfoils and streamlines; Forces acting on an airplane - lift and drag, types of drag; Factors affecting lift and drag; Types of flow and their governing equations; Speed and power. Straight and level flight; Conditions for minimum drag and minimum power; Gliding, cruise and climbing flight; Range and endurance; Takeoff and landing; V-n diagram.

Unit-3

Aircraft Propulsion: Classification and essential features of propulsion, jet propulsion, general characteristics of rocket engines, theory of propulsion, elementary gas dynamics, spacecraft and aircraft performance

Aircraft Structures and Materials: General types of construction and structural layout, monocoque, semi monocoque, corrugated, sandwich structure, reinforced and honeycomb structures, geodesic construction, aerospace materials, metallic and nonmetallic materials, use of aluminum alloy, titanium, stainless steel, composite and ceramic materials.

Unit-4

Aircraft Instruments and Navigation: Instrument displays; Introduction to navigation instruments; Basic air data systems and probes- Mach meter, air speed indicator, vertical speed indicator, Altimeter, gyro based instruments. Measurements in aerodynamics, flight structures, and flight control, principles of navigation, celestial, radio, and inertial navigation schemes, navigational and guidance requirements for orbital, planetary, and atmospheric entry missions.

CASE STUDIES

1. Conceptual Aero-Design Analysis
2. Case Study on Investigation of Aero foil for Flapping Wing Aircraft
3. Fundamentals of Aircraft and Airship Design
4. Increasing the Efficiency of Aircraft Ground Handling—A Case

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

5. Case Study: REVA Transports with a Technology Edge.
6. Aircraft Conceptual Design Practices & Case Studies.

TEXT BOOKS

1 Merrill, G., "Principle of Guided Missile Design", Literary Licensing, LLC, 1st Edition, 2011.
2 Richard S. Shevell, “Fundamentals of Flight”, Pearson Education, 2nd Edition, 2004.
3 Pallet, E.H.J., “Aircraft Instruments & Principles”, Pitman Publishing; 2nd Edition, 1981.
4. Mattingly J.D., “Elements of Propulsion: Gas Turbines and Rocket”, AIAA, 2nd Edition, 2017.
5.Leland M. Nicolai and Grant E. Carichner, Fundamentals of Aircraft and Airship Design Volume I – Aircraft Design, AIAA Education Series, 2010

REFERENCE BOOKS:

1 Kermode, A.C., “Flight without Formulae”, Pearson India, 5th Edition, 2004.
2 Lalit Gupta and O P Sharma, “Fundamentals of Flight Vol-I to Vol-IV”, Himalayan Books, 2006
3 Anderson, J. D., "Introduction to Flight", McGraw-Hill, 8th Edition, 2015.
4. Cohen, H.Rogers, G.F.C. and Saravanamuttoo, H.I.H. “Gas Turbine Theory”, Pearson Education, 7th Edition, 2019.

JOURNALS/MAGAZINES

1. http://airspot.ru/book/file/73/hull_airplane_flight_mechanics.pdf
2. https://fas.org/irp/doddir/army/fm3-04-203.pdf
3. http://ae.sharif.edu/~iae/Download/Introduction%20to%20flight.pdf
4. http://www-pw.physics.uiowa.edu/~dag/lectures/Flight_Dec12-2003.pdf
5. https://www.freeengineeringbooks.com/AeroSpace/Aircraft-Structures-Books.php
6. https://docs.google.com/file/d/0Bw8MfqmgWLS4RlNqaE1oUzdOajQ/view?pref=2&pli=1
7. https://www.scribd.com/document/63588270/Aerospace-Propulsion-Systems
8. https://www.crcpress.com/Aircraft-Propulsion-and-Gas-Turbine-Engines/ElSayed/p/book/9780849391965

SWAYAM/NPTEL/MOOCs:

1. https://www.educba.com/course/elements-of-aeronautics/
2. https://www.udemy.com/airplane-engineering-from-zero-to-100-for-everyone/
3. https://www.edx.org/course/introduction-to-aeronautical-engineering
4. https://www.educba.com/course/elements-of-aeronautics/

<table>
<tr><td>Course Title</td><td colspan="4">Industrial Engineering</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ERS625</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VI semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Industrial engineering is an engineering profession which deals with the development, improvement and implementation of integrated systems of knowledge, information, equipment, human resources, and finance to optimize the complex engineering processes or systems and organizations, dealing in engineering work. Industrial engineering is closely associated with production engineering which intends to work towards improving the overall industrial production by design, development, implementation, operation, maintenance, and control of all processes in the manufacture of a product. Industrial and production engineering course are mostly studied as a single specialization with institutes offering production and industrial engineering degree.

COURSE OBJECTIVES

1. Develop concepts related to principles of productivity & work study.
2. Apply the concepts related to operational analysis & measuring work for designing the work systems.
3. Review the emerging concepts and principles in work system design for productivity improvement.
4. The students will be capable to do the design of jobs and work environments.

5. To provide a detailed understanding of work study and working environment.
6. To provide an adequate background for applying the concept of work study and work environment in industries.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Discuss the industrial engineering principles that influence the productivity improvement in organizations.	1	1,2,3
CO2	Apply the methods of engineering and operational analysis in re-designing of work systems.	1,2	1,2,3
CO3	Apply engineering work measurement principles in analyzing and measurement of work.	1,2	1,2,3
CO4	Analyze the work processes using advanced work study tools and techniques.	1,2, 5	1,2,3
CO5	Demonstrate an understanding of emerging concepts and applications in designing work systems.	1,2,3	1,2,3
CO6	Evaluate work study and working environment towards improving productivity	1,2	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3			✓			
CO4				✓		
CO5			✓			
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2											2	2	
CO2	3	2											2	2	
CO3	2	1											2	2	
CO4	2	1			1								2	2	
CO5	2	2	1										2	2	
CO6	3	2											2	2	
Average	2	1.7	1		1								2	2	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Scope of Industrial Engineering, Evolution of Industrial Engineering approach. Nature of work, Physical work systems, Work systems as a field of professional practice, Type of Occupation, Productivity concepts, Manual Work Systems, Worker-Machine Systems, Automated Work systems, Cycle time analysis of Manual work and in Worker machine systems, numerical, Service operations , Office work, Work study.

Unit-2

Methods Engineering and Operations Analysis: Evolution and Scope of Methods Engineering, Systematic Approach in Methods Engineering, Techniques of Methods Engineering, Selecting Alternative Improvement

Proposals, Basic Data Collection and Analysis Techniques, Methods Engineering and Automation.

Charting and Diagramming Techniques for Operations Analysis: Overview of the techniques, Network diagrams, Traditional Charting and Diagramming techniques, Block diagrams and Process maps.

Motion Study and Work Design: Basic motion elements and Work analysis, Principles of motion economy and work Design, Case Studies.

Unit-3

Introduction to Work Measurement: Determination of Time Standards – Methods, Work Measurement Techniques, Prerequisites for valid time standards, Allowances in Time Standards, Accuracy and Precision, Application of Speed Ratio.

Direct Time Study: Procedure, Determination of Number of Work Cycle to be Timed, Performance Rating, Time Study Equipment, Numerical.

Predetermined Motion Time Systems: Over view, Methods – Time Measurements, Maynard Operations Sequence Technique.

Unit-4

Standard Data Systems: Standard Data Systems overview, steps, elements classifications. Work Sampling: Statistical Basis of work sampling, Application issues in work sampling (including numerical).

Learning Curves: Determining the Learning Rate, Factors effecting the Learning Curve, Applications, Time standards vs. Learning Curve.

Computerized Work Measurement and Standards Maintenance: Computer Systems for Direct Time Study and Work Sampling, Computerized Systems Based on Predetermined Motion Times, Work Measurement Based on Expert Systems, Maintenance of Time Standards.

CASE STUDIES

1. Reducing Labor Cost using industrial Engineering techniques.
2. Work Measurement approach for productivity improvement in shop floor.
3. Enhancing of productivity for manual and automated assembly line.
4. Improvements in material handling “a case study of cement manufacturing plant".

TEXT BOOKS

1. Mikell P Groover, "The Methods, Measurement & Management of Work", Pearson India Education, 2017.
2. George Kanawaty, "Introduction to Work Study", ILO, 1992.
3. Avraham Shtub, “Introduction to Industrial Engineering”, CRC Press, 2015.

REFERENCE BOOKS

1. Fred E.Meyers and James R.Stewart, "Motion and Time study for Lean Manufacturing", Prentice Hall, ISBN: 0-13-031670-9, 2002.
2. Benjamin W Niebel, Andris Freivalds, Niebel's, "Methods, Standards, and Work Design", McGraw-Hill, ISBN: 9780073376363, 2014
3. Industrial engineering Handbook: Maynard.

JOURNALS/MAGAZINES

1. IEEE Transactions on Industrial Informatics
2. Journal of Industrial Information Integration
3. Journal of Manufacturing Systems
4. International Journal of Production Research
5. International Journal of Production Economics
6. Journal of Manufacturing Technology Management
7. Journal of Product Innovation Management
8. Journal of Management in Engineering

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc22_me04/preview

Course Title	Energy Technology				Course Type		Open Elective	
Course Code	B20MEO601	Credits	3		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course explores the concept of thermal energy conversion, also introduces the, different types of fuels used for steam generation and equipment for burning coal in lump form. This course introduces to bio mass energy and its characteristics. It also emphasizes on conversion of various biomass energy into solid, liquid and gaseous forms. Further the course deals with conversion of biomass into methanol, ethanol, biogas, bio diesel etc.

COURSE OBJECTIVES

1. To understand energy scenario, energy sources and their utilization
2. To gain the knowledge about diesel engine power plant.
3. To enhance the knowledge about renewable energy sources.
4. To enable the students to gain the knowledge on hydrogen energy generation.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Summarize the basic concepts of thermal energy systems and identify coal and ash handling systems used in steam power plants.	1	1
CO2	Identify renewable energy resources and their utilization.	1,6,7	1
CO3	Discuss the principles of energy conversion of wind, geothermal, ocean, biomass, and biogas energy systems.	1,6,7	1,2
CO4	Describe the methods used to generate Hydrogen energy.	1, 7	1
CO5	Describe the main characteristics of renewable energy sources and their comparison with fossil fuels.	1,6,7	1
CO6	Investigate the design parameters of biogas digesters.	1,2,3,7	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3			√			
CO4		√				
CO5		√				
CO6				√		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3					2	2						3		
CO3	3	2				2	2						3	2	
CO4	3						1						3		
CO5	3					2	1						3		
CO6	3	2	1										3	1	1
Average	**3**	**2**	**1**			**2**	**1.5**						**3**	**1.5**	**1**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Thermal Energy Conversion System: Review of energy scenario in India, General Philosophy and need of Energy, Different Types of Fuels used for steam generation, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace,

Coal and Ash Handling: Chimneys: Natural, forced, induced and balanced draft, Cooling towers and Ponds

Unit-2

Diesel Engine Power System: Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant.

Solar Energy and Applications: Solar radiation - Availability- Measurement and estimation- Solar radiation geometry

Hydrogen Energy: Introduction to hydrogen energy, methods of hydrogen production (electrolytic and thermo chemical method).

Unit-3

Wind Energy: Wind energy - General considerations - Wind Power plant design – Horizontal axis wind turbine

Tidal Power: Power generation using OTEC - Wave and Tidal energy - Scope and economics - Limitations**.**

Hydro-Electric Energy: General layout of hydel power plants, Hydrographs, flow duration and mass curves and numerical. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks, gates and valves.

Unit-4

Biomass Energy Sources: Biomass production for energy farming, origin of Biomass-Photosynthesis process, Energy through fermentation -Ethanol Production from sugarcane and starch, Biomass characteristics.

Bio-Methanization: Anaerobic digestion, Basic principles, factors affecting biogas yield, biogas digester (floating gas holder and fixed dome type with working principle and diagram).

Geothermal Energy Conversion: Availability - Geographical distribution.

TEXT BOOKS

1. P.K Nag, “Power Plant Engineering”, 3rd Ed. Tata McGraw Hill, 2nd edition 2001.
2. Morse F.T, Van Nstrand, “Power Plant Engineering”, 1998.
3. B H Khan, “Non-conventional energy resources”, McGraw Hill Education, 3rd Edition, 2017.
4. A. W. Culp Jr, “Principles of Energy conversion”, McGraw Hill. 1996

REFERENCE BOOKS

1. Stanier, “Plant Engg. Hand Book, McGraw Hill, 1998.
2. Domakundawar, “Power Plant Engineering”, Dhanpath Raisons, 2003
3. S.P. Sukhatme, “Solar Energy: principles of Thermal Collection and Storage”, Tata McGraw-Hill, 1984.
4. L.L. Freris, “Wind Energy Conversion Systems”, Prentice Hall, 1990.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/topics/engineering/ash-handling-plant
2. https://www.researchgate.net/publication/267838546_Survey_of_modern_power_plants_driven_by_diesel_and_gas_engines.
3. https://www.journals.elsevier.com/international-journal-of-hydrogen-energy
4. https://www.sciencedirect.com/science/article/pii/S2211467X19300379

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_me86/preview
2. https://nptel.ac.in/courses/103107157
3. https://onlinecourses.nptel.ac.in/noc21_ch11/preview
4. https://onlinecourses.nptel.ac.in/noc22_ch27/preview

Course Title	Heat Transfer Lab				Course Type		Hard Core	
Course Code	B20ER0604	Credits	1		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Heat Transfer laboratory provides fundamental and industrial knowledge about modes of heat transfer, like conduction, convection and radiation, and their application. Concepts of heat transfer are applied in the field of Heat Exchanger design and phase change phenomenon. This course deals with the concepts of thermal conductivity, convective heat transfer coefficient, Stephen Boltzmann constant, transient heat transfer, vapor compression refrigeration and Air conditioning systems.

COURSE OBJECTIVES

1. Provide knowledge on modes of heat transfer and laws governing the Heat and Mass transfer.
2. Analyze various techniques to compute the heat transfer coefficient in various heat transfer problems.
3. Conduct experiment to study variation of temperature along the length of the pin fin under forced and free Convection.
4. Carryout analysis of boiling and condensation phenomenon and design heat transfer equipment.
5. Conduct experiments related to various heat transfer processes and heat exchangers and analyze measurements data.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the three modes of heat transfer and their governing equations.	1	1,2
CO2	Perform conduction heat transfer experiment to estimate thermal conductivity of metal rod, overall heat transfer coefficient of composite slab and document the results in the form of technical report	1,2,4,10	1,2
CO3	Evaluate the heat transfer coefficients in forced convection, free convection and Correlate with theoretical values and document the results in the form of technical report.	1,2,4, 9,10	1,2
CO4	Perform experiments on radiation heat transfer to determine surface emissivity and Stefan- Boltzmann's constant and document the results in the form of technical report.	1,2,4,9, 10	1,2
CO5	Evaluate heat transfer coefficients in condensation, boiling, LMTD and effectiveness of heat exchangers and document the results in the form of technical report.	1,2,4,9, 10	1,2
CO6	Conduct experiments, interpret the data, analyse Vapour compression refrigeration, Air conditioning system and document the results in the form of technical report.	1,2,4,9, 10	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓			
CO3			✓			
CO4			✓			
CO5			✓			
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	1	
CO2	3	3		1					3	3			1	2	
CO3	3	3		1					3	3			2	1	
CO4	3	3		1					3	3			1	1	
CO5	3	3		1					3	3			1	1	
CO6	3	3		1					3	3			1	1	1
Average	**3**	**3**		**1**					**3**	**3**			**1.5**	**1.16**	**1**

Note: 1-Low, 2-Medium, 3-High

List of Experiments

1. Determination of thermal conductivity of a metal rod.
2. Determination of overall heat transfer coefficient of composite slab.
3. Analysis of heat transfer through pin-fin.
4. Experiment on transient conduction heat transfer.
5. Estimation of heat transfer coefficient for natural convection heat transfer.
6. Estimation of heat transfer coefficient for forced convection heat transfer.
7. Determination of emissivity of a surface
8. Determination of Stefan Boltzmann constant.
9. Determination of LMDT and effectiveness in a parallel flow and counter flow heat exchangers.
10. Experiment on boiling of liquid and condensation of vapour.
11. Performance test on vapour compression refrigeration.
12. Performance test on a vapour compression air – conditioner

TEXT BOOKS

1. Tirumaleshwar, "Heat & Mass transfer", Pearson Education, 2014.
2. Ozisik, Heat transfer-A basic approach, Tata McGraw Hill, 1985.

REFERENCE BOOKS

1. Yunus A-Cengel, "Heat transfer-A practical approach", Tata McGraw Hill, 2nd Edition, 2002.
2. Mahesh M Rathore, "Heat and mass transfer", Laxmi publications, 2017.
3. Frank Kreith, Raj. M. Manglik, Mark. S. Bohn, "Principles of Heat transfer", Thomas Learning, 7th Edition, 2010.
4. Frenk P.Incropera and DavidP.Dewitt, "Fundamentals of heat and mass transfer", John Wiley and son's, 5th Edition, 2007.
5. R K Rajput, "Heat and Mass transfer", S Chand Publications, 2018.

JOURNALS/MAGAZINES

1. The Journal of Heat Transfer, ASME
2. International Journal of Heat and Mass Transfer, Elsevier

SWAYAM/NPTEL/MOOCs:

1. Heat Transfer, By Prof. Ganesh Viswanathan, IIT Bombay, https://onlinecourses.nptel.ac.in/noc20_ch12/preview
2. Heat Transfer, By Prof. Sunando Dasgupta, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc19_ch23/preview

Course Title	Computer Aided Engineering Analysis Lab				Course Type		Hard Core	
Course Code	B20ER0605	Credits	1		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with the numerical approximation of complex physical structures that cannot be analyzed using standard mathematical solutions, such as Slope, Deflection, Work, energy principle etc., further the Steps involved in FEM, Selection of Elements, and A Hands-on Introduction to Engineering Simulations to analyze real-world engineering problems using ANSYS simulation software.

COURSE OBJECTIVES

1. To acquire basic understanding of Modeling and Analysis software
2. To understand the different kinds of analysis and apply the basic principles to find out the stress and other related parameters of bars, beams and truss loaded with loading conditions
3. To lean to apply the basic principles to carry out thermal and dynamic analysis

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Define and Understand the steps involved in FEM, and various commands used in ANSYS simulation software	1,2	1
CO2	Formulate finite elements like the bar, truss, and beam for linear static structural analysis.	1,2,3,5,9,12	1,2,3
CO3	Determine the Stress analysis of a rectangular plate with a circular hole	1,2,3,5,9,12	1,2,3
CO4	Demonstrate the deflection of beams subjected to point, uniformly distributed and varying loads and further to use the available results to draw shear force and bending moment diagrams	1,2,3,5,9,12	1,2,3
CO5	Carry out dynamic analysis and finding natural frequencies for various boundary conditions and also analyse with forcing function	1,2,3,5,9,12	1,2,3
CO6	Develop finite element equations for 1D and 2D heat transfer elements and record the results in the form of technical report.	1,2,3,5,9,10,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3			✓			
CO4				✓		
CO5			✓			
CO6			✓			

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												2	1	1
CO2	2	3	2		3				3			3	2	1	1

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO3	2	2	1		3				3			3	2	1	1
CO4	2	3	2		3				3			3	2	1	1
CO5	2	3	2		3				3			3	2	1	1
CO6	2	3	2		3				3			3	2	1	1
Average	**2**	**2.8**	**1.8**		**3**				**3**			**3**	**2**	**1**	**1**

Note: 1-Low, 2-Medium, 3-High

Part-A

Study of an FEA package and modeling, stress analysis of

1. Bars of uniform cross-section area, tapered cross-section area, and stepped bar
2. Trusses – (Minimum 2 exercises).
3. Beams – Simply supported, cantilever, beams with UDL, beams with varying load, etc

Part-B

1. Stress analysis of a rectangular plate with a circular hole
2. Thermal Analysis – 1D & 2D problem with conduction and convection boundary Conditions
3. Dynamic Analysis of Fixed – fixed beam for natural frequency determination subjected to forcing function

TEXT BOOKS

1. S.S.Bhavikatti, "Finite Element Analysis", New Age International publishers, 2006
2. Tripathi. R .Chandrapatla, Ashok.D.Belegundu, "Finite Elements in Engineering", 3rdEdition, PHI Publishers, New Delhi

REFERENCE BOOKS

1. Daryl. L. Logon, "Finite Element Methods", Thomson Learning 3rdedition, 2001
2. J.N.Reddy, "Finite Element Method", Mc Graw – Hill International Edition

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/finite-elements-in-analysis-and-design
2. https://www.hindawi.com/journals/mpe/si/632341/

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112104116
2. https://onlinecourses.nptel.ac.in/noc20_me91/preview

Course Title	**Technical Documentation**				**Course Type**		**FC**	
Course Code	**B20ER0606**	**Credits**	**1**		**Class**		**VI semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**1**	**1**	**13**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course describes the method used to document the procedures and tools used in testing or research and aims to describe the primary purpose of preparing an Engineering technical report. Also helps in preparing report that describes the progress, process, or results of scientific or technological research. It also covers how to prepare and include some recommendations and conclusions in report.

COURSE OBJECTIVES

1. To understand the purpose of technical documents/specifications.
2. To create effective technical documents.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Create effective written documents after an audience analysis.	1,5,9,10,12	

CO2	Recognize various forms of technical communication and Select the most appropriate format to convey the technical information.	1,5,9,10,12	
CO3	Discuss the complex technical concepts lucidly for the common man to understand easily.	1,5,9,10,12	
CO4	Adhere to formatting, best practices and avoid pitfalls.	1,5,9,10,12	
CO5	Write formal reports detailing the process, result or progress of a project.	1,5,9,10,12	
CO6	Create visually appealing documents with the incorporation of design elements, enhancing the reading experience as well.	1,5,9,10,12	

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3			√			
CO4		√				
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1				1				1	3		1			
CO2	1				1				2	3		1			
CO3	1				1				3	3		1			
CO4	1				1				2	2		1			
CO5	2				1				2	2		1			
CO6	1				1				2	3		1			
Average	**1.2**				**1**				**2**	**2.6**		**1**			

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: A basic understanding of the role of a technical writer in an organization, Audience Analysis, Topic Research, Writing the document, competitor analysis and writing own document.

Creating the Content and Technical Report: Developing Flowcharts, Block diagrams/schematics, Infographics, using MS application or other open-source tools. Creating a technical report using different styling techniques.

Unit-2

Interpretation and Report Writing: Meaning of Interpretation, need of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report , Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions

TEXT BOOK

1. C R Kothari, "Research Methodology- Methods and Techniques", New Age International, 2nd Edition, 2015.

SWAYAM/NPTEL/MOOCs:

1. Technical Writing Master Course: https://iimskills.com/technical-writing-course/
2. Technical Report Writing for Engineers The University of Sheffield: https://www.futurelearn.com/courses/technical-report-writing-for-engineers.

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

Course Title	Research Based Mini Project				Course Type		Hard Core	
Course Code	B20ER0607	Credits	1		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**2**	2	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Mini project is one of the integral parts of mechanical engineering curriculum where the students can learn and equip new skill sets by building projects practically. By doing mini projects, students can develop more skills in addition to the technical skills like critical thinking, problem solving ability, collaborating with team members, solving problems hands-on etc. This will also help them to showcase their practical skills to the recruiters and impress them.

COURSE OBJECTIVES

1. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
2. To inculcate the process of self-learning and research.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Identify problems based on societal /research needs.	1,6	1
CO2	Apply Knowledge and skill to solve societal problems in a group.	1,2,3,6	1,2
CO3	Develop interpersonal skills to work as member of a group or leader.	1,9,10	1,2
CO4	Draw the proper inferences from available results through theoretical / experimental/simulations.	1,2,5	1,2
CO5	Demonstrate project management principles during project work.	9.10,11	1,2
CO6	Communicate effectively the procedure to solve engineering problems with the engineering community and with society at large through effective reports and design documentation.	1,9,10,11,12	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√	√		
CO4				√		
CO5				√		
CO6				√	√	

COURSE ARTICULATION MATRIX

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3					2							3		
CO2	3	3	2			2							3	2	
CO3	1								3	3			3	2	

CO4	1		2		3								3	2	
CO5									3	2	3		3	2	
CO6	1								3	3	2	2	3	2	
Average	**1.8**	**3**	**2**		**3**	**2**			**3**	**2.6**	**2.5**	**2**	**3**	**2**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Research based project is aim to identify the research gap though extensive literature survey on a recent trends in mechanical engineering and allied areas. The research focus may be on modelling, simulation, experimental & analysis, model/prototype design, fabrication of new equipment, analysis of data, software development, etc. or a combination of these. Through this the team should publish a review research paper in the selected field of study.

The students have to make a project team consisting of two, three or four members. Every student in a group shall take up a project in the beginning of sixth semester in consultation with the guide and the project must be completed before the end of semester. The project team has to work to identify the research gap though extensive literature survey on a recent trends in mechanical engineering and allied areas and formulate the problem statement. The team submit a report prepared as per the guidelines/format of the university (one report per group).

TEXT BOOKS

1. Biswajit Mallick, "Innovative Engineering Projects", Entertinement Science and Technology Publication, Bhubaneswar, India, 1st Edition 2015.
2. C R Kothari, "Research Methodology- Methods and Techniques", New Age International, 2nd Edition, 2015.
3. A.K. Chitale, R.C. Gupta, "Product Design and Manufacturing", Prentice –Hall of India, Sixth Edition, 2013.

REFERENCE BOOKS

1. O. Molloy, S. Tilley and E. A. Warman, "Design for Manufacturing and Assembly: Concepts, Architectures and Implementation", Springer. USA, 2012.
2. Boothroyd, G.Peter Dewhurst and Winston A, "Knight, Product Design for Manufacture and Assembly", CRC Press, Taylor & Francis, Third Edition, 2010.
4. Navi Radjou, Jaideep Prabhu and Simone Ahuja, "JUGAAD Innovation: A Frugal and Flexible Approach to Innovation for the 21st Century", Random house India, Noida, 2012.
5. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw-Hill, Sixth Edition, 2015.

JOURNALS/MAGAZINES

1. Global Innovative research Journal: https://freeprojectsforall.com/journal-publication/
2. International Journal of Project Management: https://www.journals.elsevier.com/international-journal-of-project-management

SWAYAM/NPTEL/MOOCs:

1. Project Management: https://nptel.ac.in/courses/110104073

7th Semester

Course Title	Vibrations and Noise Engineering				Course Type		Hard Core	
Course Code	B20ER0701	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practical	0	0	0	Theory	Tutorial	IA	SEE
	Tutorial	1	2	2				
	Total	**3**	**4**	**4**	**26**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

The course aims to deal with mechanical vibration and its effects on mechanical systems. The course defines terminology associated with mechanical vibrations; study of free and forced vibrations under un-damped and damped conditions for single degree of freedom mechanical systems. The course further deals with vibration of multi-degree of freedom mechanical systems, vibration measurement and Noise Engineering.

COURSE OBJECTIVES

1. To enable the students to understand the theoretical principles of vibration and vibration analysis techniques for the practical solution of vibration problems.
2. Formulate mathematical models of problems in vibrations using Newton's second law or energy principles.
3. To analyze the free and forced (harmonic, periodic, non-periodic) vibration analysis of single and two degree of freedom linear systems.
4. To enable the students to determine sound pressure level measurement in specified acoustic environment.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the causes, effects of vibration in mechanical systems and apply basics of engineering to vibrating mechanical system and develop mathematical models to obtain their governing equations of motion and their response.	1,2,3,4	1,2
CO2	Compute the natural frequency for free and forced vibration of a single degree of freedom of un-damped and damped systems.	1,2,3	1,2
CO3	Analyze the vibratory responses of Mechanical systems for harmonic, periodic and non-periodic excitation.	1,2,3,6	1,2
CO4	Formulate the mathematical models for Two DOF mechanical vibrating system and Analyze its natural frequencies and mode shapes.	1,2,3,4	1,2
CO5	Demonstrate the Vibration measurements and its functionality.	1,2	1,2
CO6	Interpret the principles of vibration and noise reduction techniques to real life engineering problems.	1,2,3,6	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓			
CO3				✓		
CO4				✓		
CO5			✓			
CO6			✓			

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1									3	3	
CO2	3	3	2										3	3	
CO3	3	3	2			1							3	3	
CO4	3	3	2	2									3	3	
CO5	3	3				1							3	3	
CO6	3	2	1			1							3	3	
Average	**3**	**2.8**	**1.8**	**1.5**		**1**							**3**	**3**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Types of vibrations, Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force
Undamped Free Vibration - Single Degree of Freedom Systems: Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring, numerical.

Unit-2

Damped free vibrations- Single Degree of Freedom Systems: Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement, numerical.
Forced vibration - Single Degree of Freedom Systems: Introduction, Analysis of forced vibration with constant harmonic excitation- magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, Energy dissipated due to damping, numerical.

Unit-3

Vibration Measurements: Seismic instrument, frequency measuring instrument, whirling of shafts with and without damping, discussion of speeds above and below critical speed of shafts, numerical.
Vibration of Two Degree of Freedom Systems: Principle modes of vibrations, Normal mode and natural frequencies of systems (without damping) – Simple spring mass systems, masses on tightly stretched strings, double pendulum, torsional systems, combined rectilinear and angular systems, Undamped dynamic vibration absorber, numerical.

Unit-4

Noise Engineering: Subjective response of sound: Frequency and sound dependent human response; the decibel scale; relationship between, sound pressure level(SPL), sound power level and sound intensity scale; relationship between addition, subtraction and averaging, sound spectra and Octave band analysis; loudness; weighting networks; equivalent sound level, auditory effects of noise; hazardous noise, exposure due to machines and equipment; hearing conservation and damage risk criteria, daily noise doze.

CASE STUDIES

1. Develop python programming to for understanding the vibration of single degree freedom systems.
2. Develop python programming plot frequency response of single degree and multi Degree spring mass system.
3. Study the response of the Quarter car vibration.
4. Study the Bounce and pitch response of the vehicle (2 DOF).
5. Study the response of Mechanical system with variation of stiffness/Damping.

TEXT BOOKS

1. S. S. Rao, “Mechanical Vibrations”, Pearson Education Inc, 6th Edition, 2016.
2. S. Graham Kelly, “Fundamentals of Mechanical Vibrations “, Schaum’s outline Series, Tata McGraw Hill.
3. W. T. Thomson, “Mechanical Vibrations”, Pearson Education Inc, 5th Edition, 2008

4. C Sujatha, “Vibrations and Acoustics – Measurements and signal”, Tata McGraw Hill.

REFERENCE BOOKS

1. W. T. Thomson, “Theory of Vibration with Applications”, Pearson Education Inc, 5th edition, 2008.
2. V. P. Singh, “Mechanical Vibrations”, Dhanpat Rai & Company, 3rd Edition, 2006.
3. Amberkar A.G, Mechanical Vibrations and Noise Engineering, PHI Learning Pvt. Ltd, 2006.

JOURNALS/MAGAZINES

1. Journal of Sound and Vibration
2. Noise & Vibration Worldwide - SAGE Journals
3. Journal of Vibration and Acoustics
4. Journal of Vibration Engineering & Technologies
5. https://www.inceusa.org/publications/noise-news-international

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/112107212 (Introduction to Mechanical Vibration)
2. https://nptel.ac.in/courses/112104194 (Basics of Noise and Its Measurements)
3. https://www.classcentral.com/course/swayam-sound-and-structural-vibration-58554
4. https://onlinecourses.nptel.ac.in/noc22_me34/preview (Sound and Structural Vibration)

<table>
<tr><td>Course Title</td><td colspan="4">CAD/CAM/CIM</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ER0702</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VII semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Tutorial</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>1</td><td>3</td><td>3</td></tr>
<tr><td>Total</td><td>3</td><td>5</td><td>2</td><td>26</td><td>39</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

This subject explores with the technology related to the use of digital computers to perform design activities and manufacturing activities in an organization, the basic concepts and applications of conventional numerical control along with NC part programming. This course also focuses on computer technology to automate each and every function starting from market information, production processed, design activities, materials, commercial, financial required for the industry. It also deals with the reliability and performance of automated flow line involving three methods of line balancing of minimizing the total amount of idle time for a given job at a given assembly line speed.

COURSE OBJECTIVES

1. To obtain the fundamentals of CAD/ CAM / CIM and related concepts to understand the various modeling features and its manufacturing.
2. Interpret various concepts of CAD /CAM /CIM, the product development cycle can be reduced in the design stages and also reduction of Manufacturing Lead time.
3. Developing the NC programming and its importance in practical applications by using coding system.
4. To have a hands on experience on various tools used for modeling and manufacturing aspects.
5. To study about the line balancing in automated flow lines.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Apply the basic principles of CAD/ CAM to create 3D models of real-world products before they are ever manufactured.	1,2,3,5	1,2
CO2	Develop the manual NC part programming for given profile.	1,2,3,5	1,2
CO3	Identify the suitable type of automation for different production systems.	1,2	1,2
CO4	Criticize the mathematical model used in production system.	1,2	1,2
CO5	Analyze the various work transport system used in high volume production.	1,2	1,2

CO6	Formulate the line balancing of an automated assembly lines and understand advanced emerging technologies used in manufacturing.	1,2	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2			✓			
CO3		✓				
CO4			✓			
CO5				✓		
CO6			✓			

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		1								3	2	
CO2	3	2	1		1								3	2	
CO3	3	2											3	2	
CO4	3	2											3	2	
CO5	3	2											3	2	
CO6	3	2											3	2	
Average	3	2	1		1								3	2	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Fundamentals of CAD: Definition of CAD/CAM/CIM, Product cycle and its cad / cam over laid, Design process & application of computers for design, creating the manufacturing database, Benefits of CAD/CAM/CIM.

Computer Graphics: Coordinate Systems, Database Structure for Graphic Modeling, functions of graphics package, Transformation of geometry, 2D transformations – Simple problems. Geometric Modeling, types, Windowing and clipping.

Unit-2

Introduction to NC Technology Basic components of NC system, NC Coordinate system, types of NC motion control systems, advantages and applications of NC. CNC & DNC Systems: Types, advantages and its functions. Adaptive control systems.

NC/CNC Programming: NC Procedure, Manual programming and computer assisted part programming, syntax formats in part programming, G & M codes, Cutter Radius Offset, Tool Length Offset, Fixed Cycles/canned cycles, Turning and milling programs. (Using CAM software demonstrate turning and milling operations).

Unit-3

Computer Integrated Manufacturing System: Introduction to CIM and Automation, types of Automation, Model of manufacturing, Information processing cycle in manufacturing, Types of Production systems, Production Concepts & its Mathematical models, Problems. Automation Strategies.

Introduction and Analysis of Automated Flow Line: High Volume Production system: Introduction, Automated flow line, Work part transport, Buffer storage and its control functions. General terminology and analysis, Analysis of Transfer line with and without storage, numerical.

Unit-4

Assembly and Line balancing: Types of assembly system, minimum rational work element, cycle time, precedence constraints and diagram, balance delay. Methods of Line balancing – Largest candidate rule (LCR), Kilbridge and westers method, ranked positional weight method, numerical only on LCR and RPW.

Advanced Techniques in Manufacturing: Smart manufacturing, digital manufacturing, intelligent manufacturing, internet of things, cloud based manufacturing, cloud computing for manufacturing, web based manufacturing.

Practice in Tutorial Session

Sl. No	Title	Tools and Techniques	Expected Skill /Ability
1.	Autodesk Fusion 360 Basics	-	Application of Autodesk Fusion
2.	3D Modeling in Fusion 360	Familiar with Extrude, Fillet, chamfer, revolve, sweep, combine tools.	Create 3D models of real-world products before they are ever manufactured
3	3D Modeling in Fusion 360 – Creating and Modifying Solid Bodies	Familiar with Loft, Sculpt, Patch, Replace Face, Thicken	

Note:

1. After having hand on experience on 3D Modeling in Autodesk Fusion 360, student is expected to develop concept model and prepare product design of automotive components, domestic components Household products, aerospace components, etc.
2. First three to four weeks will be hands-on training on 3D Modeling in Fusion 360 will be given to students.
3. In remaining tutorial session each student is expected to develop concept and prepare a model of automotive components, household products and aerospace components. (At least one each segment).
4. Performance in tutorial session will be evaluated for 20 Marks.

TEXT BOOKS

1. M.P.Groover and Emory W.Zimmer, "CAD/CAM, Computer Aided Design and Manufacturing", Pearson India, 2nd Edition. 2007
2. Mikell P.Groover, "Automation, Production System & Computer Integrated Manufacturing", Pearson India, 2nd Edition. 2007

REFERENCE BOOKS

1. Ibrahim Zeid, "CAD/CAM theory and practice", Tata McGraw Hill. 2007.
2. P. Radha Krishnan, S. Subramanyan & V. Raju, "CAD/CAM/CIM", New Age international Publishers, 2nd Edition. 2008.
3. P. Radha Krishnan, "Computer Numerical Control Machines and CAM", New Age international Publishers, 1st Edition 2012.
4. P. N. Rao, "CAD/CAM Principles and applications", Tata McGraw Hill.2010.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/Computer Aided Design
2. https://www.sciencedirect.com/journal/Advancements in CAD/CAM technology: Options for practical implementation

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112102102
2. https://nptel.ac.in/courses/112104289

Course Title	Mechatronics and Control Systems				Course Type		Hard Core	
Course Code	B20ER0703	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course focuses on various aspects of mechatronics and control engineering. Over view on various sensors and transducer used for measurement and detecting the input signal for various applications. It provides information about signal conditioning devices and micro controllers to be used in mechatronics devices. It also provides knowledge on control engineering about mathematical modeling and analysis of mechanical system and electrical system. Also enable the students to understand the time response analysis and stability analysis of control system.

COURSE OBJECTIVES

1. To understand various aspects of mechatronics system
2. To acquire the knowledge on transducers, sensors and actuators
3. To understand working of signal conditioning devices and micro controllers
4. To develop the skills on mathematical modeling and analysis of system under time domain
5. To study the stability of system by using R H criteria and root locus technique.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Identify the key elements of mechatronics system and interface sensors / transducer output with microprocessor for design or controlling of the system.	1,2	1,3
CO2	Explain working of electrical actuators, controllers and select the desired actuator/drives/controller for the design of given mechatronics system.	1,2	1,3
CO3	Understand the concept of signal processing and explain the use of signal conditioning / interfacing systems and microcontrollers in the design of mechatronics systems.	1,2,3	1,2,3
CO4	Develop mathematical models and transfer function for mechanical and electrical system.	1,2,3	1,2,3
CO5	Perform time response analysis of first and second order system.	1,2,3	1,2,3
CO6	Examine the stability of the system using Routh's-Hurwitz Criterion and root locus plot.	1,2,3	1,2,3

BLOOM'S LEVELOF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3			✓			
CO4				✓		
CO5				✓		
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2											3	1	2
CO2	2	2											3	1	2
CO3	3	2	2										3	2	2
CO4	3	3	2										3	3	2
CO5	3	3	2										3	3	2
CO6	3	3	1		1								3	3	2
Average	**2.6**	**2.5**	**1.7**		**1**								**3**	**2.1**	**2**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction to Mechatronics Systems and Actuators: Definition of mechatronics, components of mechatronics, Basic Terminologies, Open loop and Closed loop control systems, microprocessor based control systems, ATM, Washing machine, Static and dynamic characteristics of sensor, Capacitance sensor, Eddy current sensor, Hall effect sensor-Light sensors, optical encoders, Actuation System- mechanical-Electro mechanical, electrical switches, solid state switches, solenoid.

Unit-2

Drives: AC, DC, Servo motors, stepper motors, hybrid motors.

Signal Conditioning Devices: amplifier, filters, multiplexers, de multiplexers, ADC, DAC.

Micro Controllers: Introduction, classification of micro controllers and its application, Arduino processor-Introduction, Architecture and application.

Unit-3

Introduction to Mechanical System Modeling: Real time applications, Transfer Functions- models of mechanical systems (translational and rotational) and electrical systems, Introduction to block diagram and signal flow graph.

Time Response Analysis: Types of inputs, first order and second order system response to step input, time response specifications and concepts of time constant, numerical problems.,

Unit-4

Stability Analysis: Routh's-Hurwitz Criterion, stability analysis using root locus plots, Introduction to PI, PD and PID controllers.

CASE STUDIES

1. Mathematical modeling of shock absorber used in Indian Automobile vehicles.
2. Time response analysis of shock absorber using Matlab / Simulink software.
3. Stability analysis by constructing root locus plot using Matlab / Python Code.

TEXT BOOKS

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson Education, 5th Edition, 2021.
2. W.Bolton "Mechatronics", Pearson Publications, 7th Edition, 2018.
3. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International Publishers, 6th Edition, 2017.

REFERENCE BOOKS

1 Devdas shetty and Richard A. Kolk "Mechatronics System Design" Cengage Learning, 2nd Edition, 2011.
2. B.C.Kuo, F.Golnaraghi "Automatic Control Systems", John Wiley & Sons, 9th Edition 2014.
3. Richard C Dorf & Robert H Bishop," Modern Control Systems", Prentice Hall, 13th Edition, 2016.

JOURNALS/MAGAZINES

1. https://www.journals.elsevier.com/mechatronics
2. https://www.sciencedirect.com/journal/mechatronics
3. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=87

4. https://www.journals.elsevier.com/control-engineering-practice

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112103174
2. https://www.classcentral.com/course/swayam-mechatronics-23047
3. https://nptel.ac.in/courses/107106081
4. https://www.edx.org/course/dynamics-control-upvalenciax-dc201x-0

Course Title	Engineering Economics and Financial Management				Course Type		Hard Core	
Course Code	B20ER0704	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course explores the importance of economics in the industries. Engineering economics is an interdisciplinary subject in which financial aspect of the industrial product and investment interest rates are discussed. The course emphasis on evaluation of different interest rates, comparison of different alternatives using PW, AW, FW and Internal rate of return. This subject also deals with evaluation of selling price and depreciation, financial aspects such as book keeping, ratios and budgeting.

COURSE OBJECTIVES

1. To Study principles and techniques of economic evaluation in different field of Engineering
2. To know the assessment procedure for the evaluation of alternatives.
3. To calculate interest under various conditions.
4. To learn Budgeting process and its preparation.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the economic and financial benefits of organization in the decision making process related to engineering activities.	1,11	1,2
CO2	Analyze the financial statements to evaluate financial status of engineering projects for different interest rates.	1,2,11	1,2
CO3	Estimate the present, annual and future worth comparisons for each of the cash flows.	1,2,11	1,2
CO4	Calculate the rate of return, depreciation charges and income taxes.	1,2,11	1,2
CO5	Identify financial strength and weakness of organization by considering various financial Ratios.	1,2,11	1,2
CO6	Use management techniques to enumerate different cost entities in estimation, costing and budgeting.	1,2,11	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3			✓			

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO4			✓			
CO5			✓			
CO6			✓			

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3								1		1		1	3	
CO2	3	3									3	1	1	3	
CO3	3	3	2	1					1		3	1	1	3	
CO4	3	3	2	1							3	1	1	3	
CO5	3	3	1								3		1	3	
CO6	3	3									3		1	3	
Average	3	3	1.6	1					1		2.6	1	1	3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction to Engineering Economy: Introduction to Indian Economy, Basic terminologies used in economy, Engineering Decision- Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy. Law of demand and supply, Interest and Interest factors: Interest rate, Cash – flow diagrams, numerical.

Present-Worth Comparisons: Conditions for present worth comparisons, Basic Present worth Comparisons, Present-worth equivalence, Net Present worth, Assets with unequal lives, infinite Lives, Future-worth comparison, Simple Exercises.

Unit-2

Evaluation of Projects and Depreciation: Annual worth method, and internal rate of return method. Numerical covering all the above method with comparisons. Rate-of-Return Calculations, Minimum acceptable rate of Return, ERR, IRR.

Depreciation: Causes of Depreciation, Methods of depreciation. Simple Numerical, Tax- Direct and Indirect tax, GST and simple concepts of taxing.

Unit-3

Estimation, Costing and Final Accounts: Estimation for simple components (with calculations of all types of costs involved in it). Introduction, Scope of Finance, and Finance Functions, Statements of Financial Information: Source of financial information, financial statements, Balance sheet, Profit and Loss Account, relation between Balance sheet and Profit and Loss account, Numerical.

Unit-4

Financial Ratio Analysis: Introduction, Nature of ratio analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Evaluation of a firm's earning power, numerical.

Profit Planning: Financial planning, Profit planning, Objectives of Profit planning, type of budgets in Indian Economy, preparation of Budgets, advantages, problems on flexible budget, cash budget and production budget.

CASE STUDIES:

1. Computation of different financial ratios for various sectors by using current financial annual report.
2. Comparison of the quarterly results of various manufacturing and IT sectors for the financial year and preparation of the financial statement with total revenue and Net profit.
3. SWOT analysis of Manufacturing sectors and Interpretation of opinions for the Investors.

TEXT BOOKS

1. R Paneerselvam, “Engineering Economy”, PHI Publishers, 2nd Edition, 2013.
2. Thuesen H.G. “Engineering Economy”, PHI, 9th Edition, 2002.

REFERENCE BOOKS

1. Riggs.J L, "Engineering Economy", McGraw Hill, 4th edition, 2002.
2. O P Khanna, "Industrial Engineering and Management", Dhanpat Rai & Sons. 2018
3. Prasanna Chandra, "Financial Management", TMH, 10th Edition, 2019.
4. IM Pandey, "Financial Management", Pearson, 12th Edition, 2021.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology
2. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/122/102/122102008/

Course Title	IoT and Machine Learning in Manufacturing				Course Type		Soft Core	
Course Code	B20ERS711	Credits	3		Class		VII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems. IIoT links the automation system with enterprise, planning and product lifecycle. In this course, Introduced to the series objectives and an overview of digital transformations in manufacturing in today's business world. The course also introduces machine learning, with various aspects involved in machine learning, supervised learning, and various algorithms in supervised learning. There is emphasis on implementation of optimization techniques using machine learning.

COURSE OBJECTIVES

1. To introduce basics of Internet of things.
2. To impart the knowledge of IoT and M2M for different application in Industrial Internet of things
3. To give exposure the basic theory underlying machine learning.
4. To introduce machine learning techniques for the prediction, analyze and optimization of the machining parameters.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Understand the IoT enabling technologies	1	1,2
CO2	Identify and select IoT structures for the given applications	1,2	1,2
CO3	Apply the concept of M2M for building architectural block of IoT device	1	1.2
CO4	Implement Machine learning technique for intelligent Manufacturing system	1,2,5	1,2
CO5	Apply new tools and technologies in machine learning and apply for suitable optimization problems	1,2,5	1,2
CO6	Develop machine learning algorithms for optimization of metal cutting parameters	1,2,5	1,2

BLOOM'S LEVELOF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√					

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO2		√				
CO3	√					
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	
CO2	3	2											3	3	
CO3	3												3	3	
CO4	3	2			1								3	3	
CO5	3	2			1								3	3	
CO6	3	2			1								3	3	
Average	**3**	**2**			**1**								**3**	**3**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction to IoT: Definition – Significance of IoT, Characteristics of IoT-Physical Design of IoT – Logical Design of IoT- IoT enabling technologies, Scope–Sensors for IoT Applications–Structure of IoT– IoT Map Device.

M2M to IoT: A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies.

Unit-2

M2M to IoT-An Architectural Overview:

Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. IoT Device – Basic building blocks of an IoT Device – Exemplary Device: Raspberry Pi

IoT Platforms Design Methodology:

Introduction – IoT Design Methodology, concept of the Industrial Internet of Things – Case study IoT enables CNC Machining, Real time machine monitoring.

Unit-3

Introduction to Machine Learning: Machine Learning basics, challenges, Applications, methods of Machine Learning, performance metrics, Data preprocessing, Data Loading, Understanding data with statistics, understanding data with visualization, preparing data, data feature selection.

Unit-4

Supervised Learning – Performance metrics: accuracy, misclassification, confusion matrix, similarity/dissimilarity methods, Decision Tree, K-nearest neighbor, logistic regression, support vector machine algorithm, naive Bayes algorithm, bagging and boosting techniques: random forest algorithm.

Identification of Optimal Parameters using supervised learning techniques, Build an optimization model to study the metal cutting parameters using machine learning.

TEXT BOOKS

1. Arshadeep Bahaga, Vijay Madisetti,"Internet of things-A hands –on approach", Universities Press, 1st Edition, 2015
2. Adrian McEwen and Hakim Cassimally,"Designing the Internet of Things", Wiley, 1st Edition, 2014.
3. Russell & Norvig, "Artificial Intelligence: A Modern Approach", Prentice-Hall, 3rd Edition, 2010.
4. Tom Mitchell, "Machine Learning", McGraw-Hill, 1st Edition, 2017.

REFERENCE BOOKS

1. Dominique DGuinard and Vlad M.Trifa,"Building the Web of things with examples in Node.js and Raspberry Pi", Manning Publications Co, 2016.
2. Elaine Rich, Kevin Knight, "Artificial Intelligence", TataMcgraw Hill, 3rd Edition, 2009
3. https://www.tutorialspoint.com/machine_learning_with_python/index.htm

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/artificial-intelligence

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

2. https://www.jair.org/index.php/jair

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/106105077
2. https://onlinecourses.nptel.ac.in/noc22_ge29/preview

Course Title	Robotic Systems Dynamics and Control				Course Type		Soft Core	
Course Code	B20ERS712	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

Robot Dynamics is really important since it will give you a complete understanding not only how robots move (kinematics) but also WHY they move (dynamics). In this course, you will learn to develop the dynamics models of basic robotic systems, as well as create intelligent controllers for them.

COURSE OBJECTIVES

1. To control both the position and orientation of the tool in the three dimensional space.
2. The relationship between the joint variables and the position and the orientation of the tool.
3. Planning trajectories for the tool to follow on order to perform meaningful tasks.
4. To precisely control the high speed motion of the system.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Apply the transformation methods for defining new position and orientation of the objects in 3 dimensional space.	1,2	1,2
CO2	Understand Langrangian equation of motions and link tensors.	1,2	1,2
CO3	Apply the knowledge of Lagrange-Euler dynamic model to different axis robots.	1,2	1,2
CO4	Elaborate the plan of trajectories for the robot end effectors to perform specific task.	1,2	1,2
CO5	Identify workspace and work envelope for different types of robots.	1,2	1,2
CO6	Apply Langrangian mechanics to solve dynamic equation of planer and articulated robot.	1,2	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2		✓				
CO3			✓			
CO4			✓			
CO5			✓			
CO6			✓			

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3	1	
CO2	3	2											3	1	
CO3	2	3											2	3	
CO4	2	3											2	3	
CO5	3	2											3	1	
CO6	2	3											2	3	
Average	2.5	2.5											2.5	2	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Position and orientation of objects, objects coordinate frame Rotation matrix, Euler angles Roll, pitch and yaw angles coordinate Transformations, Joint variables and position of end effector, Dot and cross products, coordinate frames, Rotations, Homogeneous coordinates.

Unit-2

Manipulator Dynamics: Introduction, Lagrange's equation kinetic and potential energy. Link inertia Tensor, link Jacobian Manipulator inertia tensor. Gravity, Generalized forces, Lagrange-Euler Dynamic model, Dynamic model of a Two-axis planar robot, Newton Euler formulation, Lagrange - Euler formulation, problems.

Unit-3

Work Space Analysis and Trajectory Planning: Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - continuous path motion, Interpolated motion, straight line motion and Cartesian space technique in trajectory planning.

Unit-4

Introduction to Motion Control: Introduction, Langrangian mechanics, Effects of moments of Inertia, Dynamic equation for two axis planar and articulated robot.

TEXT BOOKS

1. Schilling, Robert J. “Fundamentals of Robotics: Analysis and Control”. Simon & Schuster Trade, 1996.
2. Niku, Saeed B. “Introduction to Robotics: Analysis, Systems, Applications”. Vol. 7. New Jersey: Prentice hall, 2001.

REFERENCE BOOKS

1. Craig, John J. “Introduction to Robotics: Mechanics and Control”. Pearson Education, 2005.
2. Deb, Satya Ranjan, and Sankha Deb. “Robotics Technology and Flexible Automation”. McGraw-Hill Education, 2010.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
4. Saha S K, “Introduction to Robotics”, Tata McGraw Hill Education Pvt. Ltd, 2010.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/robotics-and-autonomous-systems
2. https://www.sciencedirect.com/journal/robotics

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_me76/preview

Course Title	Computational Fluid Dynamics				Course Type		Soft Core	
Course Code	B20ERS713	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with introduction to computational dynamics, solution of continuity, momentum, and energy equations using the finite volume method. Students are trained to use commercial CFD tools for fluid flow modelling, discretization and solution of equations.

COURSE OBJECTIVES

1. To acquire the basic knowledge of concepts of Computational fluid dynamics.
2. To provide the students with sufficient background to understand the mathematical representation of the governing equations of fluid flow and heat transfer applications.
3. To enable the students to solve the problem using the discretization technique.
4. To analyze the techniques, skills, & engineering tools necessary for engineering practice by applying numerical methods to a "real-world" fluid-flow problems,
5. To integrate various numerical techniques in formulating a numerical solution method.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Gain the fundamental Knowledge of computational fluid dynamics and describe boundary conditions and numerical errors.	1	1,2
CO2	Derive the governing equations related to CFD applications.	1,2	1,2
CO3	Analyze the fluid flow fields using discretization techniques.	1,2	1,2
CO4	Apply turbulence models for fluid flow analysis over immersed bodies.	1,2,3,4,5,6	1,2
CO5	Demonstrate the procedure used for analyzing fluid flow characteristics performance using CFD tool.	1,2,3,4,5,6,9	1,2,3
CO6	Solve real-world applications related fluid flow analysis using CFD tools.	1,2,3,4,5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3				✓		
CO4			✓			
CO5					✓	
CO6					✓	

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3	2	
CO2	3	3	1	1									3	2	
CO3	3	3	1	1									3	2	
CO4	3	3	1	1									3	2	
CO5	3	3	1	1	2				1				3	2	2
CO6	3	3	1	1	2				1				3	2	2
Average	3	2.83	1	1	2				1				3	2	2

Note: 1-Low, 2-Medium, 3-High

Unit-1

Introduction and Basic Governing Equations: Introduction to CFD, advantages, Limitations of CFD, applications of CFD in different fields, the future of computational fluid dynamics, Different forces acting on the fluid, Governing equations of fluid dynamics-Continuity, Momentum and energy equations in differential form, Boundary conditions-Neumann, and Dirichlet, Numerical errors -.truncation error, round off error, Discretization error.

Unit-2

CFD Techniques: Basic aspects of discretization, Discretization techniques- Finite Element Method, Finite difference method and Finite volume method, Comparison of discretization by the three methods - three-dimensional continuity equation in Cartesian coordinates, Introduction to Finite differences- – Explicit, Implicit and Crank-Nicolson methods, Stability criterion.

Unit-3

Simulation Techniques: Important features of turbulent flow, Reynolds average Navier Stokes (RANS) equation, Necessity of turbulence modeling, Different types of turbulence model: discussion on - Turbulent kinetic energy and dissipation, one equation- Spalart-Allmaras, two-equation model: κ-ε model, Advantages and disadvantages, RNG κ-ε model and κ-ω model, Multiphase flow.

Unit-4

Application of CFD: Geometry creation, meshing, grid-independent test, mesh refinement analysis, practical boundary condition, validation, and results. Convergence, accuracy, Discussion on Advanced topics in CFD - Virtual reality meets, Fluid structure interaction, Physiological Fluid Dynamics, Discussion on Practical problems using CFD tools.

CASE STUDIES

1. Analysis of Laminar Flow through Pipe
2. Analysis of orifice meter
3. Analysis of Fluid Flow over a Car.
4. A Numerical Investigation of the Incompressible Flow through a Butterfly Valve Using CFD
5. Explain briefly how to simulate a NACA 0012 Airfoil at a 6 degree angle of attack placed in a wind tunnel, using FLUENT.
6. Study of Flow around a Rotating Cylinder

TEXT BOOKS

1. J. D Anderson, “Fundamental of Computational fluid dynamics”, McGraw-Hill Publications, 6th Edition, 2017.
2. Jiyuan Tu “Computational Fluid Dynamics – A practical approach“, Butterworth Heinemann, 3rd Edition, 2018.

REFERENCE BOOKS

1. K. Muralidhar, T. Sundarajan “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2nd Edition, 2003.
2. Suhas V Patankar, “Numerical Heat Transfer and Fluid Flow”, CRC Press, 1st Edition, 2018.

JOURNALS/MAGAZINES

1. International Journal of Computational Fluid Dynamics, Taylor and Francis.
2. Progress in Computational Fluid Dynamics, An International Journal, Inderscience Publishers.

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

SWAYAM/NPTEL/MOOCs:

1. Computational Fluid Dynamics, by Prof. Suman Chakraborty, IIT Kharagpur (https://onlinecourses.nptel.ac.in/noc21_me126/preview)
2. Foundation of Computational Fluid Dynamics, by Prof. Vengadesan, IIT Madras

Course Title	Micro Electro Mechanical Systems				Course Type		Soft Core	
Course Code	B20ERS714	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course explores the field of micro electro mechanical systems (MEMS). This necessitates an understanding of the design, manufacturing, and materials concerns associated with microsystems. The course will cover fabrication technologies, material properties, basic sensing and actuation principles and MEMS applications. The course will emphasize the fabrication and materials of microsystems.

COURSE OBJECTIVES

1. Understand the fundamentals of micro manufacturing methods.
2. Recognize and connect the different sensors and actuators to applications.
3. Identify the materials and the fabrication processes that are used in MEMS devices
4. Analyze the materials used in MEMS.
5. To develop MEMS applications for several fields

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Recognize MEMS and Microsystems applications in engineering	1	1,2
CO2	Explain the working of micro devices, micro systems and their applications.	1	1,2
CO3	Explain the fabrication techniques used to develop micro electro mechanical systems.	1,5	1,2
CO4	Apply material science principles to sensor design.	1	1,2
CO5	Identify the materials utilized in sensor designs.	1	1,2
CO6	Develop micro devices and microsystems by conceptualizing and designing them.	1, 3	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3		✓				
CO4			✓			
CO5		✓				
CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	1	
CO2	3												3	1	
CO3	3				1								3	1	
CO4	1												3	1	
CO5	3												3	1	
CO6	3		1										3	1	3
Average	2.67		1										3	1	3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Overview of MEMS and Microsystems: MEMS & Microsystems, typical products, Evolution, Microsystems and microelectronics, Multidisciplinary nature, Microsystems and miniaturization, Applications of Microsystems in automobile and other industry.

Working Principle of Microsystems: Biomedical and biosensors. Micro sensors: Acoustic, Chemical, Optical, Pressure, Thermal.

Unit-2

Materials for MEMS and Microsystems: Structure of silicon and other materials, Silicon wafer processing -Bulk micromachining and Surface micromachining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching.

Unit-3

Micro Actuation: Using thermal forces, shape memory alloys, piezoelectric crystals and electrostatic forces.

MEMS with Micro Actuators: Microgrippers, micromotors, microvalves and micropumps, micro accelerometers, microfluidics.

Introduction to Scaling: Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electrostatic forces, scaling in electromagnetic forces and scaling in fluid mechanics.

Unit-4

Microsystem Fabrication Process: Introduction to microsystems, Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, PVD-Sputtering, Deposition of Epitaxy, Etching, LIGA process: General description, Materials for substrates and photoresists, Electroplating and SLIGA process.

CASE STUDIES

1. Commercial MEMS Case Studies: The Impact of Materials, Processes and Designs.
2. Fabrication of MEMS devices - a scanning micro mirror case study- principle, design, and fabrication of a silicon-based scanning micromirror with a new type of action mechanism as an example of MEMS.
3. MEMS Manufacturing Testing: An Accelerometer Case Study
4. Introduction to Applications and Industries for Microelectromechanical Systems (MEMS) - MEMS fabricated combustible gas sensor.

TEXT BOOKS

1. Tai-Ran Hsu, “MEMS & Microsystems Design and Manufacture”, Tata McGraw Hill Education, 2nd Edition, New Delhi. 2002
2. Chang Liu,” Foundations of MEMS”, Pearson Education Inc., 2012.

REFERENCE BOOKS

1. Vijay K Varadan, K. J. Vinoy, S. Gopalakrishnan, “Smart Material Systems and MEMS”, Wiley, 2015.
2. The MEMS Handbook, Mohamed Gad-el-Hak, Taylor and Francis Publication, 2006.
3. James J Allen, “MEMS Design”, Taylor and Francis Publication, 1st Edition, 2005.

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

JOURNALS/MAGAZINES

1. https://www.journals.elsevier.com/micro-and-nano-engineering
2. https://www.sciencedirect.com/topics/nursing-and-health-professions/microelectromechanical-system
3. https://www.memsjournal.com/

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/117105082
2. https://nptel.ac.in/courses/108106165/

Course Title	Total Quality Management and Six Sigma				Course Type		Soft Core	
Course Code	B20ERS715	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The course offers fundamental aspects of quality, quality control and management. The course provides insights into basic approaches of total quality management (TQM), evolution of quality management and contributions of quality gurus to the development of TQM. Techniques and tools which Focus on customer satisfaction and their involvement in the TQM program are included .The course presents various tools and techniques which are widely used in continuous improvement (CI) and TQM implementation programs. Various quality management tools, six sigma methodology (DMAIC) and design for six sigma (DFSS) techniques are also elaborated in this course.

COURSE OBJECTIVES

1. To provide the knowledge of quality and its evolution
2. To introduce the basics of leadership and customer perception of quality
3. To impart the knowledge of quality tools
4. To attain the knowledge of six sigma and its methodology

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the principles of total quality management and to explain how these principles can be applied within quality management systems.	1,2	1,2,3
CO2	Explore the various dimensions of customer satisfaction and their involvement	1,2	1,2,3
CO3	Use appropriate process improvement techniques for measuring and improving quality control.	1,2	1,2,3
CO4	Select appropriate statistical techniques for improving processes and analyze the strategic issues in quality management.	1,2,5	1,2,3
CO5	Analyze and apply six sigma methodology for design optimization of process.	1,2,3,5	1,2,3
CO6	Use simulation tools to enhance the process capability.	1,2,5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2			✓			

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO3				✓		
CO4			✓			
CO5			✓			
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1										3	1	1
CO2	3	2	1										3	1	1
CO3	3	3			1								3	1	1
CO4	3	1			1								3	1	1
CO5	3	2	1		1								3	1	1
CO6	3	3	1										3	1	1
Average	3	2.2	1		1								3	1	1

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Principles and Practices: Basic approach, gurus of TQM, TQM frame work, awareness, defining quality, historical review, obstacles, benefits of TQM.

Leadership: Definition, characteristics of quality leaders, leadership concepts, Deming philosophy, role of TQM leaders, implementation, strategic planning communication

Unit-2

Customer Satisfaction and Customer Involvement: Perception of quality, feedback using customer complaints, service quality, translating needs into Requirements, Kano model, customer retention. Employee involvement - Motivation, employee surveys, Empowerment teams, suggestion system, recognition and reward, gain sharing, performance appraisal

Unit-3

Continuous Process Improvement: Juran triology, improvement strategies, PDCA cycle, problem solving methods, Kaizen, 5S concepts, six sigma. Tool and Techniques - Statistical process control-7QC tools,
Benching marking, information technology, quality management systems, QFD, FMEA, product liability, Total productive maintenance. TQMEX model.

Unit-4

Quality Management Tools: Forced filed analysis, nominal group techniques, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, process decision program chart and activity network diagram.

Design for Six Sigma: Introduction to DMAIC approach and DFSS, tools for concept development, design development, design optimization and design verification problems.

CASE STUDIES

1. Implementation of Total Quality management for an automobile industry.
2. Gillette's TQM Successfully Story
3. Implementation of Six Sigma - A successful journey in various firm.
4. Generic Electrics Six -Sigma Journey

Note: Student can do certification course on 6σ-yellow belt

TEXT BOOKS

1. Dale H.Bester field, “Total quality Management”, Pearson Education India, 5 Edition, 2019.
2. M.Zairi, “Total quality Management for Engineers”, McGraw-Hill’s, 3rd Edition, 1991.

REFERENCE BOOKS

1. Shoji shiba, Aln Graham, David Walden, “A new American TQM, four revolutions in Management”,

Productivity Press, Orgeon, 1990.
2. Gopal K.Kanji and Mike Asher, "100 Methods for TQM", Sage Publications, Inc., 1st Edition.
3. H.Lal, "Organizational Excellence through TQM" New age Publication.
4. Poornima M Charanth, Total Quality Management, Pearson Publication, 4th Edition, 2022.

JOURNALS/MAGAZINES

1. https://www.emerald.com/insight/publication/issn/0265-671X - International journal of quality and Reliability Management
2. https://www.emerald.com/insight/publication/issn/2040-4166---- internal journal of six sigma

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_mg03/preview
2. https://nptel.ac.in/courses/110104085

Course Title	Internship Phase-1				Course Type		Soft core	
Course Code	B20ERS716	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	3	3	3	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**0**	**39**	**50 %**	**50 %**

COURSE OVERVIEW

The internship in field of study is essential to successful outcomes after graduation. Classroom environment may involve only with discussion, debate, peer interaction, and shared learning experiences. But it is important to seek opportunities for a student to apply academic concepts according to industrial requirements.

COURSE OBJECTIVES

1. To gain a practice-oriented and 'hands-on' working experience in the real world and to enhance the student's learning experience.
2. To develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in real organizational setting.
3. To enhance operational, customer service, life-long knowledge and skills in a real world work environment.
4. To get pre-employment training opportunities and an opportunity for the company or organization to assess the performance of the student and to offer an employment opportunity after his/her graduation, if it deems fit.

.**COURSE OUTCOMES (COs)**

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Solve real life challenges in the workplace by analyzing work environment and conditions, and selecting appropriate skill sets acquired from the course.	1, 2	1, 2
CO2	Demonstrate the application of knowledge and skill sets acquired from the course and workplace in the assigned job functions.	1,2,3	1, 2
CO3	Articulate career options by considering opportunities in company, sector, industry, professional and educational advancement.	1, 2, 5, 6	1, 2
CO4	Communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means.	9, 10, 11, 12	1, 2
CO5	Exhibit critical thinking and problem solving skills by analyzing underlying issue/s to challenges.	1, 2, 3,4	1, 2, 3
CO6	Exhibit professional ethics by displaying positive disposition during internship	7,8	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1				✓		
CO2				✓		
CO3				✓		
CO4				✓		
CO5				✓		
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											3	3	
CO2	3	3	3										3	3	
CO3	3	3			3	3							3	3	
CO4									3	3	2	2	3	3	
CO5	3	3	3	1									3	3	2
CO6							2	2					3	3	
Average	3	3	3	1	3	3	2	2	3	3	2	2	3	3	2

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Student who will get opportunity to undergo paid internship during 7th semester is permitted to register for internship pahse-1 course. Student should prepare a comprehensive report to indicate what he/she has observed and learnt in the training period. The student may contact Faculty Mentor taking guidance on how to make presentation and preparation of report. Student should prepare the final report on internship topic.

The Internship report will be evaluated on the basis of following criteria:

I. Originality.
II. Adequacy and purposeful write-up.
III. Organization, format, drawings, sketches, style, language etc.
IV. Variety and relevance of learning experience.
V. Practical applications, relationships with basic theory and concepts taught in the course.

Evaluation through Seminar Presentation, Assignments/Case Studies /Simulation and Viva-Voce:

The student expected to give a seminar / presentation and submit of case studies / assignment/ simulation whichever the faculty mentor expect.

The evaluation will be based on the following criteria:

I. Submission of Assignment/Case Studies/Simulation Solution relevance to Internship completed.
II. Quality of content presented.
III. Proper planning for presentation.
IV. Effectiveness of presentation.
V. Depth of knowledge and skills.
VI. Report Writing

TEXT BOOKS

1. C R Kothari, "Research Methodology- Methods and Techniques", New Age International, 2nd Edition, 2015.
2. A.K. Chitale, R.C. Gupta, "Product Design and Manufacturing", Prentice –Hall of India, Sixth Edition, 2013.

Course Title	Fluid Power Engineering				Course Type		Soft Core	
Course Code	B20ERS721	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The Fluid Power Engineering course is designed to equip delegates with the basic foundation knowledge and building blocks that underpin all hydraulic pneumatic systems. This course deals with the basic components and functions of hydraulic and pneumatic systems. Fluid power has the highest power density of all conventional power-transmission technologies. Learn the benefits and limitations of fluid power, analyze fluid power components and circuits, and design and simulate fluid power circuits for applications. Topics include standard symbols, pumps, control valves, control assemblies, actuators, maintenance procedures, and switching and control devices.

COURSE OBJECTIVES

1. To attain the knowledge of hydraulic and pneumatic systems.
2. To familiar with the power transmission in hydraulic cylinders and motors and solve the Problems.
3. To impart the knowledge on controlling components of hydraulics and pneumatics systems.
4. To understand the hydraulic and pneumatic circuits and interpret their applications.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Apply the concept of Pascal's law for designing of fluid power devices.	1,2	1,2
CO2	Identify and select the hydraulic and pneumatic components for the various applications	1,2	1,2
CO3	Design the hydraulic, pneumatic power circuits for the given applications and simulate using fluidSIM software.	1,2,3,5	1,2
CO4	Identify and select the suitable fluids for the fluid power applications.	1,2	1,2
CO5	Analyze the performance of fluid power components.	1,2	1,2
CO6	Use PLCs for controlling of fluid power devices.	1,2	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2		✓				
CO3				✓		
CO4		✓				
CO5					✓	
CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											3	1	
CO2	3	3											3	1	
CO3	3	3	1		1								3	1	

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO4	3	2											3	1	
CO5	3	2											3	1	
CO6	3	2											3	1	
Average	**3**	**2.5**	**1**		**1**								**3**	**1**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction to Fluid Power: Pascal's law, Applications of Pascal's Law, Basics of Hydraulics, Structure of Hydraulic System- Numerical on Pascal's law. Advantages and Disadvantages of fluid power, Application of fluid power system

Hydraulic Pumps: Pumping theory, Gear pump, Vane Pump, Piston pump, construction and working of pumps, pump performance, Factors for selection of pumps, Numerical on calculation of volumetric displacements, eccentricity and efficiencies of hydraulic pumps.

Unit-2

Control Valves and Fluid Power Actuators: Control Valves-DCV: Check valve,3/2, 4/3, 5/3, 5/2, Solenoid operated DCV working, PRV: Pressure regulating and reducing valve, FCV: needle valve, Linear hydraulic actuators, Types of hydraulic cylinders, Single acting, Double acting, Special types of cylinders, Loading Mechanism, Cylinder Mounting, Cylinder load, speed and power, numerical.

Rotary Actuators: construction and working of motors, External Gear motor, Vane motor, Piston motor, Applications of Hydraulics Motors, Hydraulic motor performance, Numerical.

Unit-3

Hydraulic Circuits: Fluid Power Symbols, Single acting, Double acting, Regenerative, Double pump, Sequencing, Cylinder locking, Synchronizing, pump unloading circuit, counter balance circuit, Meter-in, Meter-out, Accumulators and Applications of Accumulators using circuits.

Demonstration: Hydraulics circuit design, simulation using FluidSIM software.

Maintenance of hydraulic Systems: Hydraulic oils, Desirable properties, Sealing Devices, Reservoirs System, Filters and strainers, Beta Ratio in filters, Problem caused by Gases in Hydraulic Fluids, Wear of moving parts to solid particle contamination, Temperature control, Trouble shooting.

Unit-4

Pneumatic Systems and Components: Pneumatic Components: Properties of air, types of Compressors, Filter, Regulator, and Lubricator Unit, Air control valves, Quick exhaust valves, and pneumatic actuators. Servo systems, Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics, Introduction to fluidic devices, simple circuits, Introduction to programmable logic controllers (PLC), Applications of PLCs in Fluid power sectors, Pneumatic logic circuits by using OR & AND logic gates.

Demonstration: Pneumatics circuit design, simulation using FluidSIM software.

TEXT BOOKS

1. Anthony Esposito, "Fluid Power with Applications", Seventh Edition, Pearson Education, 2013.
2. Majumdar S.R, "Oil Hydraulics", Tata McGraw-Hill, New Delh, 2017

REFERENCE BOOKS

1. Majumdar S.R, "Pneumatic systems – Principles and Maintenance", Tata McGraw Hill, New Delhi, 2017.
2. James R. Daines, Martha J. Daines, "Fluid Power: Hydraulics and Pneumatics", Goodheart-Willcox; 3rd Edition, 2021.
3. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 2nd Edition, 1982.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/procedia engineering.
2. https://link.springer.com/article/10.1631/jzus.A1500042

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/ 112106300/
2. https://nptel.ac.in/courses/ 112105046/

Course Title	Tribology				Course Type		Soft Core	
Course Code	B20ERS722	Credits	3		Class		VII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Tribology deals with design of fluid containment systems like seals and gasket, Lubrication of surfaces in relative motion to achieve reduced friction and wear. The structure of the bearing and the nature of fluid flow determine the loads that can be supported. Modeling systems as hydrostatic squeeze film and Elasto-hydrodynamic lubrication will be studied as infinite and later finite structures. Gas (air) lubricated and rolling contact type motions with deformation at contact will be studied as special systems.

COURSE OBJECTIVES

1. To introduce tribology as an important aspect in design consideration in performance of machine components that are in relative motion.
2. To understand the importance of friction and wear in the process of designing components for functional applications.
3. To recognize the need of lubrication in machine components and bearings.
4. To analyze the mechanism of pressure development in fluid film in journal bearing.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Study the properties of Oil seals, Gaskets industrial tribology.	1	1,2
CO2	Analyze the friction and wear behavior in interacting surfaces.	1,2	1,2
CO3	Apply the principles of lubrication in designing of bearings.	1,2,3	1,2
CO4	Analyze the pressure of fluid film and estimate the load carrying capacity of journal bearing.	1,2	1,2
CO5	Analyze and interpret the power loss due to friction in Journal bearing.	1,2,4	1,2
CO6	Study the Interatomic Interactions in nano scale lubricants using Atomic Force Microscope.	1	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3			✓			
CO4				✓		
CO5		✓				
CO6			✓			

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												3	3	
CO2	3	2											3	3	
CO3	3	3	1										3	3	
CO4	3	3											3	3	
CO5	3	2		2									3	3	
CO6	3												3	2	
Average	2.8	2.5	1	2									3	2.8	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Introduction to tribology, History of tribology, Interdisciplinary approach, Economic benefits. Tribological Design of Oil seals, Gaskets.

Friction: Laws of friction - Stick-slip phenomenon, Friction characteristics of metals and non-metals.

Unit-2

Wear - Wear mechanisms – Interfacial wear and Chemical Wear-Wear measurements - Ferrography and oil analysis.

Lubrication & Bearings: Lubrication types, Regimes, Basic Modes of Lubrication, Properties of Lubricants. Types of bearings.

Unit-3

Hydrodynamics Lubrication: Fluid film in simple shear, Mechanism of pressure development in a convergent film, pressure induced, and velocity induced flows, Reynold's equation for fluid film lubrication, Load carrying capacity of slider bearing &Journal bearing Pressure development.

Unit-4

Lubrication in Bearings: Sommerfeld Number, Friction – Petroff's equation – Oil flow and Thermal equilibrium. Gas Lubricated Bearings.

Nanoscale Tribology: Interatomic Interactions, Atomic Force Microscope (AFM), Automotive Tribology.

CASE STUDIES

1. Study on Systematic oil analysis in late 1940s with the railways. The early applications were oriented toward avoiding catastrophic and costly failures of engines in operation and Success in rail engines.
2:.Study on Derailment of Train upon deformed bearing hub.
3. Study on Premature Bearing failures in Brick Clay mill.
4. Study on Jaw Crusher Machine Failure.

TEXT BOOKS

1. Gwidon W Stachowiak and Andrew W Batchelor, "Engineering Tribology", Butterworth-Heinemann. 2013.
2. K.C. Ludema, "Friction, Wear, Lubrication", CRC Press, 2010.

REFERENCE BOOKS

1. Majumdar.B.C, Introduction to Tribology of Bearings, Universal Books, 2010.
2. Bharat Bhushan, Introduction to Tribology, John Wiley & Sons, 2013.

JOURNALS/MAGAZINES

1. https://www.journals.elsevier.com/tribology-international
2. https://www.mdpi.com/journal/lubricants

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/112102015
2. https://onlinecourses.nptel.ac.in/noc20_mm12/preview

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

Course Title	Solar Energy Systems				Course Type		Soft Core	
Course Code	B20ERS723	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The course content is designed to provide comprehensive knowledge on solar radiation, fundamentals of the solar thermal and photovoltaic systems, the solar thermal collectors and their applications. It also deals with solar thermal energy storage devices, Photovoltaic systems, types, and their applications.

COURSE OBJECTIVES

1. To provide the basic knowledge on solar and earth geometry, the different devices used to measure the solar radiation.
2. To explain the classification, working of thermal energy storage devices and their applications.
3. To gain the knowledge of different available technologies to store the solar energy.
4. To summarize the types of photovoltaic systems, used to convert the solar energy into electric energy and their applications.
5. To design and analyze the Thermal and Photovoltaic system for different applications.

COURSE OUTCOMES (COs)

On completion of the course the student shall be able to:

CO	Course Outcomes	POs	PSOs
CO1	Explain about the solar geometry, construction and working of instruments used to measure solar radiation.	1	1
CO2	Identify different solar collector systems and select suitable solar collector system.	1	1
CO3	Explain the construction and working of thermal energy storage systems.	1	1
CO4	Demonstrate the knowledge on construction and working of solar PV cells.	1	1
CO5	Identify different types of PV system applications for stand-alone with and without battery storage.	1	1
CO6	Analyze the requirements, Interpret the data and design the sustainable, environmental friendly Thermal and PV systems for the society.	1,2,3,5,6,7	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3		✓				
CO4		✓				
CO5		✓				
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3												3		
CO3	3												3		
CO4	3												3		
CO5	3												3		
CO6	3	3	2		1	2	3						3	2	2
Average	**3**	**3**	**2**		**1**	**2**	**3**						**3**	**2**	**2**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: - Solar radiation at the earth's surface, Sun and earth geometry, Solar constant, Solar angles, sunrise, sunset and day length, Instruments for measuring solar radiation and Sunshine, Simple Numerical on Solar radiation geometry

Unit-2

Solar Thermal Collectors: Classification of solar collectors, Flat plate collectors with plane reflectors, cylindrical parabolic collector, Compound parabolic collector (CPC), Paraboloid dish collector, Central receiver collector. Transmissivity of the cover system, Alternative to the conventional collector.

Thermal energy storage: Need for solar thermal energy storage, Sensible heat storage, Latent heat storage, Thermochemical storage.

Unit-3

Solar Photovoltaic System: Working principle of Photovoltaic system, Current voltage characteristics of a solar cell, Types of solar cells: Crystalline silicon solar cells, Thin-film solar cells, multifunctional solar cells, other solar cells, Losses in solar cells and solar modules, Photovoltaic modules in series and parallel

Unit-4

Photovoltaic system and its applications: Stand-alone system with and without battery storage and with AC and DC load, Grid connected, Concentrated photovoltaic systems, satellite power station.

Design of Solar Thermal and Photovoltaic: Design of solar flat plate collector system, Design of PV system for domestic applications.

Discussion on use of software for installation of Solar PV Cells, Flat plate collectors and other applications.

CASE STUDIES

1. Prepare a report on latest specifications and problems of solar water heaters to be implemented for a residential purpose for heating water.
2. Prepare a report on specifications and devices used for a solar roof top PV Systems for a residential purpose.
3. Prepare a report on power saving, money saved by using a solar roof top invertor.
4. Preparer a report on the power developed by solar power plant and problems faced.
5. Prepare a survey report on development of solar power plants in Karnataka.
6. Prepare a survey report on development of solar power plants in India.
7. Prepare a report on the specifications of devices used for measuring the solar energy.
8. Using solar PV software calculate the different parameters for solar panels.

TEXT BOOKS

1. S P Sukhatme and J K Nayak, "Solar Energy", McGraw Hill Education (India) Private Limited, 4th Edition, 2017.
2. John A Duffie and William A Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, Inc., 4th edition April 2013

REFERENCE BOOKS

1. Martin A Green, "Solar cells: operating principles, technology, and system applications", Prentice-Hall series in solid state in physical electronics, Longman Higher Education, 1st Edition, 1982.

2. Garg. H.P, Prakash.J, "Solar energy fundamentals and applications", Tata McGraw Hill publishing Co. Ltd, 1st Edition, 2017.
3. Yogi Goswami.D, Frank Kreith, Jan F.Kreider, "Principle of solar engineering", Taylor and Francis, 2nd Edition, 2000.
4. Chetan Singh Solanki, "Solar Photovoltaic technology and systems: A manual for Technicians, Trainers and Engineers", PHI Learning private limited, 1st Edition, 2013.

JOURNALS/MAGAZINES

1. https://www.journals.elsevier.com/solar-energy-materials-and-solar-cells
2. https://www.journals.elsevier.com/solar-energy

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/115103123
2. https://www.coursera.org/learn/photovoltaic-solar-energy
3. https://www.coursera.org/learn/solar-energy-basics
4. https://onlinecourses.nptel.ac.in/noc20_ee57

<table>
<tr><td>Course Title</td><td colspan="4">Autonomous Vehicles</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ERS724</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VII Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

The goal of the course is to introduce students to the various technologies and systems used to implement advanced driver assistance systems. These systems have the overall impact of automating various driving functions, connecting the automobile to sources of information that assist with this task, and allowing the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants.

COURSE OBJECTIVES

1. Introduce the fundamental aspects of Autonomous Vehicles.
2. Gain Knowledge about the Sensing Technology and Algorithms applied in Autonomous vehicles.
3. Understand the Connectivity Aspects and the issues involved in driverless cars.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the evolution of Automotive Electronics and the operation of ECUs.	1,2	1,2
CO2	Compare the different type of sensing mechanisms involved in Autonomous Vehicles.	1,2	1,2
CO3	Discuss about the use of computer vision and learning algorithms in vehicles.	1,2	1,2
CO4	Summarize the aspects of connectivity fundamentals existing in a driverless car.	1,2	1,2
CO5	Identify the different levels of automation involved in an Autonomous Vehicle.	1,2	1,2
CO6	Outline the various controllers employed in vehicle actuation.	1,2	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3		√				
CO4		√				
CO5		√				
CO6		√				

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1											1	1	
CO2	1	2											1	1	
CO3	2	2											1	2	
CO4	2	2											1	2	
CO5	2	2											1	2	
CO6	2	3											1	2	
Average	**1.8**	**2**											**1**	**1.6**	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit 1

Introduction: Evolution of Automotive Electronics, Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs -Infotainment, Body, Chassis, and Powertrain Electronics, Advanced Driver Assistance Systems, Autonomous Vehicles

Unit 2

Sensor Technology for Autonomous Vehicles: Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems, Camera Technology -Night Vision Technology, Use of Sensor Data Fusion, Kalman Filters

Unit 3

Computer Vision and Deep Learning for Autonomous Vehicles: Computer Vision Fundamentals -Advanced Computer Vision, Neural Networks for Image Processing, Tensor Flow, Overview of Deep Neural Networks, Convolutional Neural Networks Connectivity Fundamentals, DSRC (Direct Short Range Communication), Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Security Issues.

Unit 4

Autonomous Vehicle Technology Driverless Car Technology-Different Levels of Automation, Localization, Path Planning. Controllers to Actuate a Vehicle, PID Controllers, Model Predictive Controllers, ROS Framework, Technical Issues, Security Issues, Moral and Legal Issues.

TEXT BOOKS

1. Hong Cheng, "Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation", Springer, 2011.
2. Williams. B. Ribbens: "Understanding Automotive Electronics", 7th Edition, Elsevier Inc., 2012.

REFERENCE BOOKS

1. Shaoshan Liu, Liyun Li, "Creating Autonomous Vehicle Systems", Morgan and Claypool Publishers, 2017.
2. Marcus Maurer, J.ChristianGerdes, "Autonomous Driving: Technical, Legal and Social Aspects" Springer, 2016.

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

3. Ronald.K.Jurgen, “Autonomous Vehicles for Safer Driving”, SAE International, 2013.
4. James Anderson, KalraNidhi, Karlyn Stanly, “Autonomous Vehicle Technology: A Guide for Policymakers”, Rand Co, 2014.
5. Lawrence. D. Burns, ChrostopherShulgan, “Autonomy – The quest to build the driverless car and how it will reshape our world”, Harper Collins Publishers, 2018

JOURNALS/MAGAZINES

1. Journal of Autonomous Vehicles and Systems
2. International Journal of Vehicle Autonomous Systems

SWAYAM/NPTEL/MOOCs

1. https://www.mooc-list.com/course/introduction-self-driving-cars-coursera
2. https://www.mooc-list.com/course/decision-making-autonomous-systems-edx
3. https://www.mooc-list.com/course/visual-perception-self-driving-cars-coursera

<table>
<tr><td>Course Title</td><td colspan="4">Operation Research</td><td colspan="2">Course Type</td><td colspan="2">Soft core</td></tr>
<tr><td>Course Code</td><td>B20ERS725</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VII semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

The course of operation Research focuses on optimization. Optimization problems arise in all walks of human activity –particularly in engineering, business, finance and economics. The simplest optimization problems are linear in nature which may be subject to a set of linear constraints. This course will equip the student with the expertise to mathematically solve problems in linear programming, transportation, Waiting lines, sequencing, Game Theory and subsequently educate the student to solve these problems with the help of the available methods.

COURSE OBJECTIVES

1. Learn Fundamentals of OR, Formulation of an LPP. And determine the optimal solution fora LPP Problem
2. Learn applications of LPP such as transportation problem, Assignment problem, travellingsalesman problem
3. Analyze the waiting line model for real world applications.
4. Determine the project completion time by using PERT and CPM.
5. Determine the scheduling of machines in the shop floor by using Johnson‘s algorithm.
6. Understand the conflict between the two players in a game and determine the best strategy for the play.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Formulate & Analyze the different models of Operation research & their applications.	1,2,12	1,2
CO2	Solve transportation problem to determine optimal route and assignment for real time applications.	1,2,12	1,2
CO3	Design and develop a model to improve decision making and objective analysis of decision problems.	1,2,3,12	1,2
CO4	Interpret the characteristics of various waiting line problems	1,2,12	1,2

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

CO5	Determine optimal sequencing and best strategy of the play	1,2,12	1,2
CO6	Ascertain the optimization techniques to real life problems	1,2,12	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3				✓		
CO4				✓		
CO5				✓		
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										1	3	3	
CO2	3	3										1	3	3	
CO3	3	2	3									1	3	3	
CO4	3	3										2	3	3	
CO5	3	3										2	3	3	
CO6	3	3										3	3	3	
Average	3	2.6	3									1.67	3	3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction to Operation Research: Definition, Scope of OR, OR Models, Characteristics and phases of OR. Advantages and limitation of OR. Mathematical formulation of LPP, Assumptions in LPP. Graphical solutions of LPP, Convex and non-convex sets.

Linear Programming Problem: Slack, surplus and artificial variables, Simplex method & BIG-M, Concept of duality, Special cases such as unbounded solution, multiple optimal solution, infeasible solution & degeneracy.

Unit-2

Formulation of Transportation Model: Determination of IBFS using different methods & optimality by modi (V-V) method. Balanced and unbalanced transportation Problem, Degeneracy in transportation problems and resolving degeneracy, maximization of transportation problem. Application of Transportation Problem.

Assignment Model: Hungarian Method, Formulation of the assignment model (Minimization and Maximization), Balanced and unbalanced model, travelling salesman problem.

Unit-3

Network Analysis – PERT & CPM Techniques: Project scheduling, Basic terminology used in project network, network construction, time estimates, determination of critical path and its durations, Floats , Variance under probabilistic models, prediction of project completion date.

Waiting Line Model: Queue system and characteristics of queuing models, Kendall's notation, classification of the queue. The M/m/1:∞/FCFS queuing system, Numerical

Unit-4

Game Theory: Introduction, Definition, strategy, Formulation of games, pay off matrix, Maximin and minimax criteria, Saddle point, Types of games. Solution of game with and without saddle point, Graphical solution of 2 X n game & M X 2 game. Dominance property for rectangular game i.e., M x N game.

Sequencing : Johnson's algorithm, Assumptions in sequencing, n jobs to 2 machines, n jobs on 3 machines, n jobs on m machines, 2 jobs on n machines, graphical solution priority rules, processing of n jobs through m machines.

CASE STUDIES

1. Develop a python programming for solve linear programming problem.
2. Formulation of the problem by using linear programming model for managing of waste in metropolitan cities.
3. Optimization of the optimal route and cost for connecting various cities in the state.
4. Analyzing the various characteristics of the queuing system in day to day service sector.
5. Application of network techniques for various manufacturing and service sector- A case study

TEXT BOOKS

1 Prem Kumar Gupta and D.S.Hira, "Problems in Operations Research", S.Chand Publication, New Delhi, 2021.
2.S.D.Sharma, "Operations Research", Kedar Nath Ram Nanth, New Delhi, 8th Revised Edition 2017

.**REFERENCE BOOKS**

1 Fredericks Hiller and Gerald J Liberman, "Introduction to Operation Research", Tata McGraw hill, Special Indian edition 9th Edition, 2017.
2. Taha.H.A, "Operation Research: An Introduction", Pearson Education Indian Edition, 2014.
3. A Ravindran, "Operation Research: Principles and Practice", John Wiley and Sons Ltd, 2nd Edition, 2004.
4. S Kalavathy, "Operation Research", Vikas Publishing house Pvt Ltd, 3rd Edition, 2009

JOURNALS/MAGAZINES

1. https://www.inderscience.com/jhome.php?jcode=ijor
2. https://www.springer.com/journal/12597

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/110106062
2. https://nptel.ac.in/courses/112106131

Course Title	Internship				Course Type		Soft core	
Course Code	B20ERS726	Credits	3		Class		VII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	3	3	3	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**0**	**39**	**50 %**	**50 %**

COURSE OVERVIEW

The internship in field of study is essential to successful outcomes after graduation. Classroom environment may involve only with discussion, debate, peer interaction, and shared learning experiences. But it is important to seek opportunities for a student to apply academic concepts according to industrial requirements.

COURSE OBJECTIVES

1. To gain a practice-oriented and 'hands-on' working experience in the real world and to enhance the student's learning experience.
2. To develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in real organizational setting.
3. To enhance operational, customer service, life-long knowledge and skills in a real world work environment.
4. To get pre-employment training opportunities and an opportunity for the company or organization to assess the performance of the student and to offer an employment opportunity after his/her graduation, if it deems fit.

.**COURSE OUTCOMES (COs)**

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Solve real life challenges in the workplace by analyzing work environment and conditions, and selecting appropriate skill sets acquired from the course.	1, 2	1, 2
CO2	Demonstrate the application of knowledge and skill sets acquired from the course and workplace in the assigned job functions.	1,2,3	1, 2
CO3	Articulate career options by considering opportunities in company, sector, industry, professional and educational advancement.	1, 2, 5, 6	1, 2
CO4	Communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means.	9, 10, 11, 12	1, 2
CO5	Exhibit critical thinking and problem solving skills by analyzing underlying issue/s to challenges.	1, 2, 3,4	1, 2, 3
CO6	Exhibit professional ethics by displaying positive disposition during internship	7,8	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1				✓		
CO2				✓		
CO3				✓		
CO4				✓		
CO5				✓		
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											3	3	
CO2	3	3	3										3	3	
CO3	3	3			3	3							3	3	
CO4									3	3	2	2	3	3	
CO5	3	3	3	1									3	3	2
CO6							2	2					3	3	
Average	3	3	3	1	3	3	2	2	3	3	2	2	3	3	2

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Student should do internship for 21 days in one stretch or 15 days in two slot before the commencement of 7th semester classes. The internship can be completed during the summer or winter vacations.

Student should prepare a comprehensive report to indicate what he/she has observed and learnt in the training period. The student may contact Faculty Mentor taking guidance on how to make presentation and preparation of report. Student should prepare the final report on internship topic.

The Internship report will be evaluated on the basis of following criteria:

I. Originality.

II. Adequacy and purposeful write-up.

III. Organization, format, drawings, sketches, style, language etc.

IV. Variety and relevance of learning experience.

V. Practical applications, relationships with basic theory and concepts taught in the course.

Evaluation through Seminar Presentation, Assignments/Case Studies /Simulation and Viva-Voce:

The student expected to give a seminar / presentation and submit of case studies / assignment/ simulation whichever the faculty mentor expect.

The evaluation will be based on the following criteria:

I. Submission of Assignment/Case Studies/Simulation Solution relevance to Internship completed.
II. Quality of content presented.
III. Proper planning for presentation.
IV. Effectiveness of presentation.
V. Depth of knowledge and skills.
VI. Report Writing

TEXT BOOKS

1. C R Kothari, "Research Methodology- Methods and Techniques", New Age International, 2nd Edition, 2015.
2. A.K. Chitale, R.C. Gupta, "Product Design and Manufacturing", Prentice –Hall of India, Sixth Edition, 2013.

Course Title	**Electric and Hybrid Vehicles**				**Course Type**		**Open Elective**	
Course Code	**B20MEO701**	**Credits**	**3**		**Class**		**VII semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course is targeting students who wish to pursue research & development in industries or higher studies in the field of Electric and Hybrid Vehicles and upcoming market for retrofit of existing IC engine vehicles with electric motors. It also offers in depth knowledge about working of an Electric Vehicle by covering study of Vehicle fundamentals of EVs and its various components. The course gives an introductory level knowledge on working fundamentals of different electric motors, motor controllers, control techniques, electric vehicle drive train, regenerative braking and different types of hybrid vehicles.

COURSE OBJECTIVES

1. To provide the students with sufficient knowledge on series, parallel and complex hybrid architectures of automobile vehicles.
2. To enable the students to understand the concept of electric drive trains, hybrid architectures and hybrid power plant specifications.
3. To help the students to understand the concept of sizing the drive system, energy storage and their alternatives, energy management and control system.
4. To provide the knowledge of the various hybrid and load tracking architectures with knowledge on Hybrid power plant specifications.
5. To impart knowledge on various energy management and control strategies, energy storage systems like batteries and alternate energy storage systems like fuel cells.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Describe the systems of electric vehicles, hybrid electric vehicles and their relevance to society and environment.	1,6,7	1

CO2	Recognize different configurations of power trains used in hybrid vehicles and identify the hybrid load tracking architectures.	1	1
CO3	Illustrate the working of different types of electrical machines, motors and drive topologies.	1	1
CO4	Demonstrate the electric propulsion unit and Identify the communication protocols and technologies used in vehicle networks.	1	1
CO5	Analyze performance of battery based energy storage and problems associated with battery systems used in electric hybrid vehicles.	1, 2	1
CO6	Describe the characteristics of fuel cell technology.	1	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3			✓			
CO4			✓			
CO5		✓				
CO6		✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3					2	2						2		
CO2	3												3		
CO3	3												2		
CO4	3												3		
CO5	3	1											2		
CO6	2												3		
Average	**2.8**	**1**				**2**	**2**						**2.5**		

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Introduction: Sustainable Transportation, A Brief History of EHVs, Need of EHV technology, Architectures of EHVs, social and environmental importance of hybrid and electric vehicles, Challenges and Key Technology of EHVs.

EHV Fundamentals: Basics of vehicle performance, vehicle power source characterization, transmission characteristic and mathematical models to describe vehicle performance

Unit-2

Hybrid Electric Drive-trains: Basic Architecture of Hybrid Drive Trains, Energy Savings Potential of Hybrid Drivetrains, Hybrid drive train configurations- series configuration, Parallel configurations, Series-Parallel configurations and complex configurations, power flow control in hybrid drive-train topologies

Basic Architecture of Electric Drive Trains: Electric Vehicles drive train configurations, Introduction to various electric drive-train topologies, Electric Vehicle (EV) drivetrain Alternatives Based on Drivetrain Configuration, Electric Vehicle (EV) Drivetrain Alternatives Based on Power Source Configuration.

Unit-3

Electric Propulsion unit: Electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, introduction to Permanent Magnet Motors.

Control Systems for the EHV and EVs: In vehicle networks- CAN, Energy Management Strategies: Energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

Unit-4

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery Parameters, Different types of Battery used in EHVs, Battery based energy storage and its analysis, Problems associated with battery systems in EHVs, Temperature controlling methods, advanced battery technologies.

Fuel Cells: Fuel Cell Characteristics - Fuel Cell Types – Alkaline Fuel Cell - Proton Exchange Membrane - Direct Methanol Fuel Cell - Solid Oxide Fuel Cell- Hydrogen Storage Systems- Reformers - Fuel Cell EV - Super and Ultra Capacitors -Flywheels.

TEXT BOOKS

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", 4th Edition, CRC Press, 2003.
2. M. Ehsani, Y. Gao and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", 2nd Edition, CRC Press, London, 2010.
3. James Larminie, John Lowry, "Electric Vehicle Technology", Wiley publications, 3rd Edition, 2003.

REFERENCE BOOKS

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", 3rd edition, Wiley, 2003
2. Seth Leitman, "Build Your Own Electric Vehicle" McGraw-Hill, 2nd Edition, 2013.
3. Chris Mi, M A Masrur, D W Gao, "Hybrid Electric Vehicles – Principles and applications with practical perspectives", 4th edition, Wiley, 2011
4. C.C Chan, K.T Chau, "Modern Electric Vehicle Technology", Oxford University Press Inc., New York 2001

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/book/9780444535658/electric-and-hybrid-vehicles
2. https://www.scimagojr.com/journalsearch.php?q=11600153305&tip=sid

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/108/103/108103009/
2. https://www.edx.org/course/electric-cars-technology
3. https://www.classcentral.com/course/edx-hybrid-vehicles-10285

<table>
<tr><td>Course Title</td><td colspan="4">Design Lab</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ER0705</td><td>Credits</td><td colspan="2">1</td><td colspan="2">Class</td><td colspan="2">VII Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>1</td><td>2</td><td>2</td><td>0</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

The course deals with the free and forced vibrations under un-damped and damped conditions for single degree of freedom mechanical systems. It also deals with the critical speed of a rotating shaft. This lab helps the manufacturing sector in analyzing the vibration measurement and Noise Engineering. Also study the mode shapes of cantilever beam. The course further deals with experimental stress analysis.

COURSE OBJECTIVES

1. To enable the students to understand the theoretical principles of vibration and vibration analysis techniques for the practical solution of vibration problems.
2. To analyze the free and forced (harmonic, periodic, non-periodic) vibration analysis of single degree of freedom linear systems.

3. To enable the students to determine sound pressure level measurement in specified acoustic environment.
4. To predict stress levels using the concepts of Photo elasticity.
5. To analyze the parameters (Principal Stresses and Strains) using strain rosettes.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Estimate the natural frequency for longitudinal and torsional systems and demonstrate a physical understanding of damping as well as frequencies and mode shapes of engineered systems and record the results in the form of technical report.	1, 4, 9, 10	1, 2
CO2	Compute the natural frequency for forced vibration of a single degree of freedom of un-damped systems and record the results in the form of technical report.	1, 3, 9, 10	1, 2
CO3	Compute the critical speed of rotating shaft and record the results in the form of technical report.	1, 3, 9, 10	1, 2
CO4	Predict the vibration using measuring instruments and noise reduction techniques to real time engineering problems and record the results in the form of technical report.	1, 4, 6, 9, 10	1, 2
CO5	Justify the Photo elasticity principles for stress analysis and record the results in the form of technical report.	1, 2, 9, 10	1, 2
CO6	Determine Principal stresses and strains in members subjected to combined loading using strain rosettes, compare it with theoretical values and record the results in the form of technical report.	1, 2, 9, 10	1, 2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓	✓				
CO2		✓				
CO3			✓	✓		
CO4	✓			✓	✓	
CO5		✓	✓			
CO6	✓	✓				

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2			3					3	3			3	3	
CO2	2		3						3	3			3	3	
CO3	3		3						3	3			2	3	
CO4	3			3		3			3	3			3	2	
CO5	2	3							3	3			3	3	
CO6	3	3							3	3			2	3	
Average	**2.5**	**3**	**3**	**3**		**3**			**3**	**3**			**2.7**	**2.8**	

Note: 1-Low, 2-Medium, 3-High

Part-A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional).
2. To study the forced damped vibration of spring mass system.

3. Determination of critical speed of a rotating shaft.
4. Vibration measurements by accelerometers/ Laser Doppler/ Vibrometer/ μ-flown probes.
5. Determination of natural frequency of beam /plate by experimental model analysis.

Part-B

1. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
2. Determination of Fringe constant of photo elastic material using.
   a) Circular disc subjected to diametral compression.
   b) Pure bending specimen (four point bending).
3. Determination of stress concentration using Photo elasticity for rectangular plate with a hole under tension.
4. Determination of Pressure distribution in Journal bearing.

TEXT BOOKS

1. S. S. Rao, "Mechanical Vibrations", Pearson Education Inc, 6th edition, 2016.
2. S. Graham Kelly, Schaum's outline Series, "Fundamentals of Mechanical Vibrations", Tata McGraw Hill.
3. W. T. Thomson, "Mechanical Vibrations", Pearson Education Inc, 5th Edition, 2008.
4. Sadhu Singh, "Experimental Stress Analysis", Khanna Publisher New Delhi, 2009.
5. Srinath L.S., "Experimental stress Analysis", Tata McGraw Hill, New Delhi.

REFERENCE BOOKS

1. G. K.Grover, "Mechanical Vibrations", Nem Chand and Bros.
2. W. T. Thomson, "Theory of Vibration with Applications", Pearson Education Inc, 5th Edition, 2008.
3. V. P. Singh, "Mechanical Vibrations", Dhanpat Rai & Company, 3rd Edition, 2006.
4. Jindal, "Experimental stress analysis", Pearson Publishers, 2018.
5. J.Srinivas, "Stress analysis-An introduction to Experimental Techniques", Narosa Publishers, 2015.

JOURNALS/MAGAZINES

1. Journal of Sound and Vibration
2. Journal of Vibration and Acoustics
3. Journal of Vibration Engineering & Technologies
4. https://www.inceusa.org/publications/noise-news-international
5. https://www.sciencedirect.com/topics/engineering/experimental-stress-analysis
6. https://link.springer.com/book/10.1007/978-3-319-06086-6

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112107212 (Introduction to Mechanical Vibration)
2. https://www.classcentral.com/course/swayam-sound-and-structural-vibration-58554
3. https://onlinecourses.nptel.ac.in/noc22_me34/preview (Sound and Structural Vibration)
4. https://onlinecourses.nptel.ac.in/noc21_me02/preview
5. https://nptel.ac.in/courses/112106068

Course Title	**CIM and Machine Learning Lab**				**Course Type**		**Hard Core**	
Course Code	**B20ER0706**	**Credits**	**1**		**Class**		**VII Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

The main purpose of this lab is to train the students industry ready and to attain employability skills with the CNC programming of canned cycles and cutting tool path generation through CNC simulation software by using

G-Codes and M-codes. Students will get acquainted about CNC Lathe part programming for Turning, Facing, Grooving, Step turning, Taper turning, Circular interpolation, Combination of few operations followed by CNC Mill Part programming for Drilling, Peck drilling, Boring, Turning, Facing, Taper turning. The course trains the students on applying machine learning techniques using python for tool life monitoring.

COURSE OBJECTIVES

1. To train the students with CNC part programming concepts
2. To generate manual part programming – CNC Turning, milling and drilling
3. To familiarize with the various operations to be performed with syntax format based on Fanuc controller.
4. To carry out the simulation /Dry run of the given profile with various operations involved in it.
5. To familiarize with the various Machine Learning Models for tool condition monitoring.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Understand the basic concept of NC programming languages – Manual Part programming and Computer assisted part programming.	1,2,5	1,2
CO2	Analyze the various operations involved in the profile with its syntax format for machining and document the results in the form of technical report.	1,2,5,9,10	1,2
CO3	Generate the part program for the given turning, drilling and Milling profile/part geometry and document the results in the form of technical report	1,2,5,9,10	1,2
CO4	Use Canned Cycles for Drilling, Peck drilling, Boring, Turning, Taper turning, Thread cutting operations and document the results in the form of technical report	1,2,5,9,10	1,2
CO5	Familiarize with the computer numerical control software and its ability to generate the cutter tool path as per given profile in the dry run and document the results in the form of technical report.	1,2,5,9,10	1,2
CO6	Apply Machine Learning Models for tool condition monitoring using Python.	1,2,5,9,10	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3			✓			
CO4			✓			
CO5			✓			
CO6				✓		

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			1								2	1	
CO2	2	3			3				2	2			2	2	
CO3	2	3			3				2	2			2	2	
CO4	2	3			3				2	2			2	2	
CO5	2	3			3				2	2			2	2	
CO6	3	2			1				1	1			2	1	
Average	**2.3**	**2.6**			**2.3**				**1.8**	**1.8**			**2**	**1.6**	

Note: 1-Low, 2-Medium, 3-High

Part-A

1. Manual CNC part programming for turning and drilling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path.
2. Simulation of Turning, Drilling operations. Typical simulations to be carried out using simulation packages like: Cadem CAMLab-Pro, Master- CAM with and without canned cycle programs.
3. Simulation of Milling operations. Typical simulations to be carried out using simulation packages like: Cadem, CAMLab-Pro, Master- CAM, M-Tab for with & without canned cycle programs

Part-B

1. Introduction to Machine Learning Techniques and implementation using Python.
2. Supervising of data acquired from CNC Machining.
3. Prediction of tool wear using Machine Learning Models.

TEXT BOOKS

1. M.P.Groover & Emory W.Zimmer, "CAD/CAM, Computer Aided Design and Manufacturing", Pearson India, 2nd Edition. 2007.
2. Mikell P.Groover, "Automation, Production system & Computer Integrated Manufacturing", Pearson India, 2nd edition. 2007.
3. Tom Mitchell, "Machine Learning", McGraw-Hill, 2nd Edition 2017.

REFERENCE BOOKS

1. Ibrahim Zeid, "CAD/CAM theory and practice", Tata McGraw hill. 2007.
2. P. Radha Krishnan, S. Subramanyan & V. Raju, "CAD/CAM/CIM", New Age international Publishers, 2nd Edition. 2008.
3. P. Radha Krishnan, "Computer Numerical Control Machines and CAM", New Age international Publishers, 1st Edition 2012.
4. P. N. Rao, "CAD/CAM Principles and applications", Tata McGraw hill, 2010.
5. Chris Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, 1995

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/Computer Aided Design
2. https://www.sciencedirect.com/journal/Advancements in CAD/CAM technology: Options for practical implementation

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112102102
2. https://nptel.ac.in/courses/112104289

8th Semester

Course Title	Total Quality Management and Six Sigma				Course Type		Open Elective	
Course Code	B20MEO801	Credits	3		Class		VIII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The course offers fundamental aspects of quality, quality control and management. The course provides insights into basic approaches of total quality management (TQM), evolution of quality management and contributions of quality gurus to the development of TQM. Techniques and tools which Focus on customer satisfaction and their involvement in the TQM program are included .The course presents various tools and techniques which are widely used in continuous improvement (CI) and TQM implementation programs. Various quality management tools, six sigma methodology (DMAIC) and design for six sigma (DFSS) techniques are also elaborated in this course.

COURSE OBJECTIVES

1. To provide the knowledge of quality and its evolution
2. To introduce the basics of leadership and customer perception of quality
3. To impart the knowledge of quality tools
4. To attain the knowledge of six sigma and its methodology

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Describe the principles of total quality management and to explain how these principles can be applied within quality management systems.	1,2	1,2,3
CO2	Explore the various dimensions of customer satisfaction and their involvement	1,2	1,2,3
CO3	Use appropriate process improvement techniques for measuring and improving quality control.	1,2	1,2,3
CO4	Select appropriate statistical techniques for improving processes and analyze the strategic issues in quality management.	1,2,5	1,2,3
CO5	Analyze and apply six sigma methodology for design optimization of process.	1,2,3,5	1,2,3
CO6	Use simulation tools to enhance the process capability.	1,2,5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2			✓			
CO3				✓		
CO4			✓			
CO5			✓			
CO6				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1										3	1	1
CO2	3	2	1										3	1	1
CO3	3	3											3	1	1
CO4	3	1											3	1	1
CO5	3	2	1										3	1	1
CO6	3	3	1										3	1	1
Average	**3**	**2.2**	**1**										**3**	**1**	**1**

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

Unit-1

Principles and Practices: Basic approach, gurus of TQM, TQM frame work, awareness, defining quality, historical review, obstacles, benefits of TQM.

Leadership: Definition, characteristics of quality leaders, leadership concepts, Deming philosophy, role of TQM leaders, implementation, strategic planning communication

Unit-2

Customer Satisfaction and Customer Involvement: Perception of quality, feedback using customer complaints, service quality, translating needs into Requirements, Kano model, customer retention. Employee involvement - Motivation, employee surveys, Empowerment teams, suggestion system, recognition and reward, gain sharing, performance appraisal

Unit-3

Continuous Process Improvement: Juran triology, improvement strategies, PDCA cycle, problem solving methods, Kaizen, 5S concepts, six sigma. Tool and Techniques - Statistical process control-7QC tools,
Benching marking, information technology, quality management systems, QFD, FMEA, product liability, Total productive maintenance. TQMEX model.

Unit-4

Quality Management Tools: Forced filed analysis, nominal group techniques, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, process decision program chart and activity network diagram.

Design for Six Sigma: Introduction to DMAIC approach and DFSS, tools for concept development, design development, design optimization and design verification problems.

TEXT BOOKS

1. Dale H.Bester field, “Total quality Management”, Pearson Education India, ISBN: 8129702606.
2. M.Zairi, “Total quality Management for Engineers”, 3rd Edition, McGraw-Hill’s, 1987.

REFERENCE BOOKS

1. Shoji shiba, Aln Graham, David Walden, “A new American TQM, four revolutions in Management”, Productivity Press, Orgeon, 1990.
2. Gopal K.Kanji and Mike Asher, “100 Methods for TQM”, Sage Publications, Inc., 1st Edition.
3. H.Lal, “Organizational Excellence through TQM” New age Publication.

JOURNALS/MAGAZINES

1. https://www.emerald.com/insight/publication/issn/0265-671X - International journal of quality and Reliability Management
2. https://www.emerald.com/insight/publication/issn/2040-4166---- internal journal of six sigma

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_mg03/preview
2. https://nptel.ac.in/courses/110104085

Ref: BOS/SME/BME-2020-21-20.06.20/2021-22-05.06.21/2022-23-25.06.22/2023-24-10.06.23

Course Title	Major Project			Course Type	Hard Core
Course Code	B20ER0801	Credits	6	Class	VIII Semester
Course Structure	TLP	Credits	Contact Hours	Assessment in Weightage	
	Theory	0	0		
	Practice	6	18	IA	SEE
	Tutorial	0	0		
	Total	**6**	**18**	**50 %**	**50 %**

COURSE OVERVIEW

This course introduces the students to professional engineering practice by providing them with an opportunity to work on an open ended engineering problem. Typically, the students would apply knowledge gained from different courses and training, which they have studied in their curriculum using methods, tools and techniques to find solution to the stated problem. It also emphasizes the importance of life-long learning as a fundamental attribute of graduate engineers.

COURSE OBJECTIVES

1. To provide a definite circumstances, to apply the leanings from various courses of the program and solve problem related to society.
2. To develop a multidisciplinary approach for problem solving.
3. To provide an exposure to take up a real life research problem, product development, industrial problem and arrive at meaningful conclusions / product design / solution.

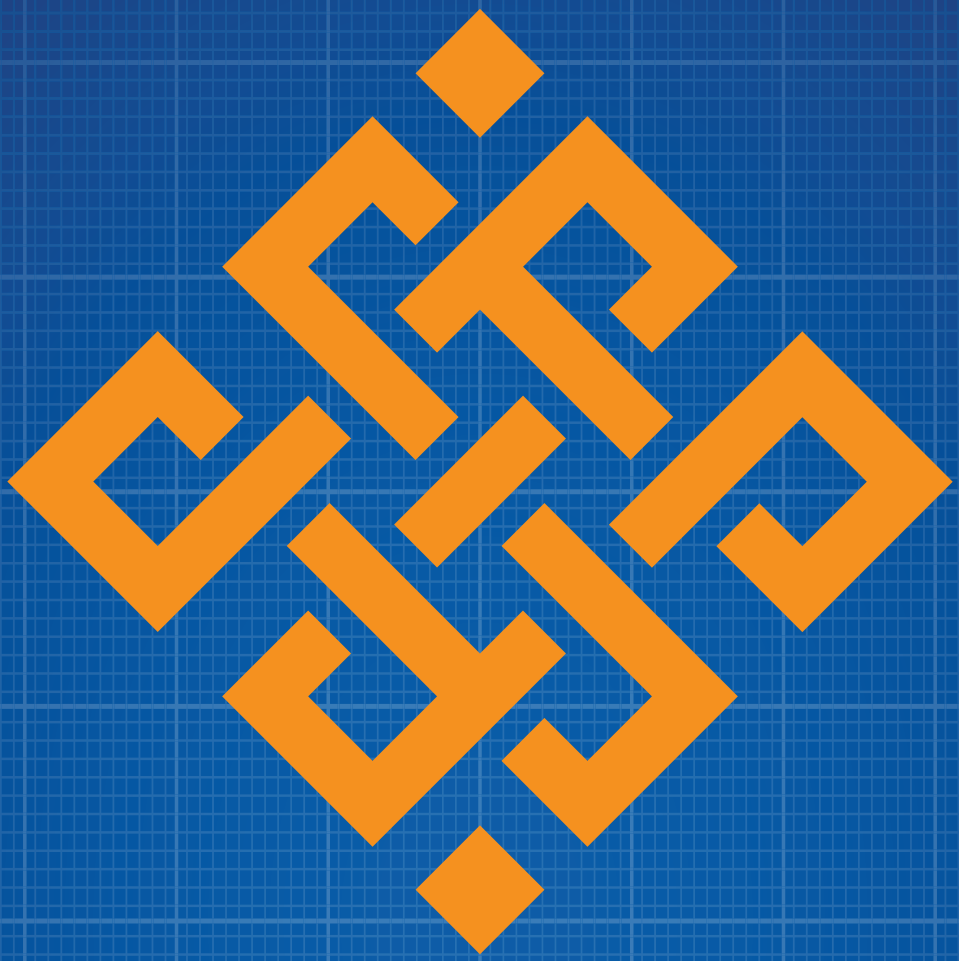
COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO	Course Outcomes	POs	PSOs
CO1	Articulate problem statements for real life problems with suitable assumptions and constraints.	1	1,2,3
CO2	Perform literature search and / or patent search in the area of interest.	2, 12	1,2,3
CO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs or understanding the social, environmental and in economic contexts.	3, 6, 7	1,2,3
CO4	Analyze data and reach a valid scientific conclusion or product or solution.	4	1,2,3
CO5	Apply appropriate techniques, resources, and modern engineering and IT tools to solve complex engineering activities as per ethical principles and norms of the engineering practice.	5, 8	1,2,3
CO6	Function effectively as a member or leader in diverse teams and in multidisciplinary settings.	9	1,2,3
CO7	Write effective reports, design documentation and make effective presentations.	10	1,2,3
CO8	Demonstrate knowledge and understanding of the engineering and management principles to manage projects.	11	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2				√		
CO3						√
CO4				√		
CO5					√	
CO6		√				
CO7				√		



Rukmini Knowledge Park, Katttigenahalli
Yelahanka, Bengaluru - 560 064
Karnataka, India

Ph: +91- 90211 90211, +91 80 4696 6966
E-mail: admissions@reva.edu.in

/revauniversity_official /REVAUniversity

/revauniversity_official /@revauniversity_official /REVA University

reva.edu.in +91 90211 90211