REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING

B.Tech

in

Mechanical Engineering

HAND BOOK

2017-21

Rukmini Knowledge Park
Kattigenahalli, Yelahanka, Bengaluru – 560064
www.reva.edu.in

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B. Tech in Mechanical Engineering

(First Semester to Eighth Semester)

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Rukmini Knowledge Park,
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Rukmini Educational
Charitable Trust

www.reva.edu.in

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

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.S. Y. Kulkarni

Vice-Chancellor, REVA University

PREFACE

Mechanical Engineering has been a very important discipline in the field of Engineering. There have been amazing developments in the field of Mechanical Engineering during these days. The curriculum is so designed keeping in mind the present day's latest technologies and scope for possible future needs of the industry. The courses offered are carefully selected that give exposure and knowledge not only in the field of core Mechanical Engineering but also in the interrelated areas like Management, Finance, Industrial Engineering and Mechatronics. Emphasis is also given to the latest technologies like MEMS, Nano-technology, CAD / CAM / CAE, Robotics, CIM, Rapid Prototyping, Virtual Manufacturing, Digital Manufacturing, Composites etc. 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 & Sustainability. 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 & Sustainability

The students will be exposed to these latest technologies during their course of study through both class room teaching and practical sessions. The school has well equipped laboratories with state of the art equipments/instruments/machines and scope for R & D activities. The students will be given hands on experience in these laboratories to suite the industrial requirements. The school has highly dedicated, experienced and well qualified staff members who impart required knowledge and skills to the students in area of Mechanical Engineering.

Dr. K .S. Narayanaswamy
Director,
School of Mechanical Engineering.

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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 12,000 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 45 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.

The University is presently offering 23 Post Graduate Degree programs, 20 Degree and PG Degree programs in various branches of studies and has 12000+ students studying in various branches of knowledge at graduate and post graduate level and 302 Scholars pursuing research leading to PhD in 18 disciplines. It has 800+ well qualified, experienced and committed faculty members of whom majority are doctorates in their respective areas and most of them are guiding students pursuing research leading to PhD.

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, Fuel 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 recognised 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 Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

As a part of our effort in motivating and inspiring youth of today, REVA University also has instituted awards and prizes to recognize the services of teachers, researchers, scientists, entrepreneurs, social workers and such others who have contributed richly for the development of the society and progress of the country. One of such award instituted by REVA University is 'Life Time Achievement Award' to be awarded to successful personalities who have made mark in their field of work. This award is presented on occasion of the "Founders' Day Celebration" of REVA University in presence of dignitaries, faculty members and students gathering and the first "REVA Life Time Achievement Award" for the year 2015 has been awarded to Shri. Kiran Kumar, Chairman ISRO on the occasion of Founder's Day Celebration, 6th January, 2016 and the second "REVA Life Time Achievement Award" for the year 2016 has been awarded to Shri. Shekhar Gupta, Renowned Journalist on the occasion of Founder's Day Celebration, 6th January, 2017.

REVA organises 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 REVAMP 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 recognised 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 classes everyday to students, faculty members, administrative staff and their family members and organises yoga camps for villagers around.

Recognizing the fast growth of the university and its quality in imparting higher education, the BERG (Business Excellence and Research Group), Singapore has awarded BERG Education Award 2015 to REVA University under Private Universities category. The University has also been honoured with many more such honors and recognitions.

ABOUT SCHOOL OF MECHANICAL ENGINEERING

Mechanical Engineering, one of the classical branches of engineering, has undergone significant transformation in recent years to measure up to the challenges in the modern world. It plays an increasingly leading role in industries that depend on high and innovative technologies such as space, automotive, defense, marine, medicine and food production. The school of Mechanical Engineering of the REVA University is headed by a dedicated and experienced Professor of Mechanical Engineering and is supported by well qualified faculty members. The school has the state-of-the-art class rooms and well equipped laboratories. The school offers B. Tech and M. Tech programs. It also has research program leading to Doctoral degree. The curriculum of both graduate and post graduate degree programs have been designed to meet the needs of the present and future mechanical engineers. It attempts to bridge the gap between academia and industries. The B.Tech program aims to prepare human resource to play a leading role in products and processes that present solutions to problems faced by the industry and society. The Master's Degree program in Machine Design and Dynamics focuses on the core and advanced applications for mechanical engineers to monitor and manage the changing conditions. The students undertaking this program strive to create engineering solutions for a cleaner, healthier, safer, quality and sustainable world.

VISION

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

MISSION

1. To impart quality education to the students and enhance their skills to make them globally competitive mechanical engineers.

2. To promote multidisciplinary study and cutting edge research and expand the frontiers of mechanical engineers profession.

3. To create state-of-art facilities with advanced technology for providing students and faculty with opportunities for innovation, application and dissemination of knowledge.

4. To prepare for critical uncertainties ahead for mechanical engineering and to face the challenges through clean, green and healthy solution.

5. 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.

ACADEMIC OBJECTIVES

1. To prepare graduates and post graduates in Mechanical Engineering who will excel in their professional career and contribute with commitment and dedication to the progress of the society and the nation.

2. To conduct cutting edge research of social relevance leading to Ph D, M Phil and Post Doctoral Degrees in Mechanical Engineering.

3. To promote faculty, researchers and students to participate in National and International conferences, seminars, workshops for sharing their experience and to disseminate through publishing in journals of repute, books and patents for benefit of the society at large.

4. To organize conferences, seminars, workshops, special lecturers, summer schools, technical talk, faculty development program etc., on emerging areas.

5. To establish incubation center and center of excellence in thrust areas in collaboration with industries.

6. To organize and promote co-curricular and extracurricular activities that inculcate among students concern to the society.

7. To undertake funded research projects from both at National and International funding agencies and carry out research that will contribute for the progress of the Industries, Society and Country as a whole.

8. To have extensive collaboration with sister schools within the university and other institutions, industries, universities, voluntary organization and such other to carry on research, extension and training programs.

9. To evolve newer methods and techniques in teaching and learning and produce modular lessons useful not only to the students of REVA University but also others.

ADVISORY BOARD

Sl No.	Particulars of Members
1	Mr. M.P. Ravindra President IUCEE, Bangalore
2	Prof. M. V. Krishna Murthy Former Professor Dept. Mechanical Engineering IIT Chennai, Madras, Former Director, VIT, Vellore
3	Prof. Anil D Sahasrabudhe Director, College of Engineering, Pune
4	Dr. K Ramachandra Former Director, GTRE, Bangalore CEO, NP-MICAV's National Design Research Forum The Institute of Engineers, Bangalore.
5	Prof. E. Abhilash Dept. Mechanical Engineering, King Khalid University Abha, Kingdom of Saudi Arabia

"When a young man leaves the institution after a course of training, he should be clean in speech and habit with a correct sense of patriotism, loyalty to the country, aptitude for initiative, love for self help, appreciation of the value of time, respect for law and order, and a knowledge of the value of the right thinking and right living, sufficiently well-equipped to fall into a position in some business or other and be able to support himself."

--- Sir. M. Visvesvaraya

Program Educational Objectives (PEO's)

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

- **PEO-1:** Exhibit skills as a member of a team in national and international organizations with highest ethics through lifelong learning.
- **PEO-2:** Pursue higher education through continuous learning with effective communication skills.
- **PEO-3:** Start own enterprise and provide solutions in mechanical engineering and allied areas.

Program Outcomes (POs)

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

- **PO-1: Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, to solve mechanical engineering problems.

- **PO-2: 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.

- **PO-3: 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.

- **PO-4: 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

- **PO-5: 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.

- **PO-6: 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.

- **PO-7: 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.

- **PO-8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

- **PO-9: Individual and Team Work:** Function effectively as an individual, and as amember or leader in diverse teams, and in multidisciplinary settings.

- **PO-10: 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.

- **PO-11: Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these toone's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

- **PO-12: Life-long Learning:** Recognize the need for, and have the preparation andability to engage in independent and lifelong learning in the broadest context of technological change.

b. Program Specific Outcomes (PSOs)

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

- **PSO-1:** Apply mechanical engineering knowledge and skills in Design, Manufacturing, Thermaland Industrial Engineering to obtain realistic outcomes.

- **PSO-2:** Identify, formulate, analyze and solve problems in Mechanical Engineering and allieddomains.

PSO-3: Conduct investigations in Mechanical Engineering and allied areas to provide optimaland sustainable solutions.

Summary of REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Four Year Graduate Degree Programs

1. Teaching and Learning Process:

The Teaching & Learning process under CBCS – CAGP of education in each course of study will have three components, namely**:** L:T:P.

(i) L= Lecture (ii) T= Tutorial (iii) 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 that equip students to acquire the much required skill component.

2. Courses of Study and Credits

a. The study of various subjects in B Tech degree program are grouped under various courses. Each of these course carries credits which are based on the number of hours of teaching and learning.

b. 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.

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

d. **A course shall have either or all the four components.** That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

e. The total credits earned by a student at the end of the semester upon successfully completing the course are L + T + P.

3. **Courses of Study**

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

a. Core Course:

A course which should compulsorily be studied by a candidate as a core-requirement is termed as a Core course. The CORE courses of Study are of THREE types, viz – (i) Foundation Course, (ii) Hard Core Course, and (iii) Soft Core Course.

b. Foundation Course (FC):

The foundation Course is a core course which should be completed successfully as a part of graduate degree program irrespective of the branch of study.

c. Hard Core Course (HC):

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.

d. **Soft Core Course (SC):**

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.

e. O**pen 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 O**pen Elective Course.**

f. Project Work / Dissertation:

Project work / Dissertation work is a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A project work carrying **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 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.**

3. Scheme, Duration and Medium of Instructions:

3.1 B Tech degree program is of 8 semesters - 4 years duration. 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. Minimum Credits to be Earned

4.1 **A candidate has to earn 192 credits for successful completion of B Tech degree** with the distribution of credits for different courses as prescribed by the university. A candidate can enroll for a maximum of 32 credits and a minimum of 20 credits per Semester. However he / she may not successfully earn a maximum of 32 credits per semester. This maximum of 32 credits does not include the credits of courses carried forward by a candidate.

4.2 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 192 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.

4.3. **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 192 credits for the B Tech Degree program.

4.3.1. Add on Proficiency Diploma:

To acquire **Add on Proficiency Diploma,** 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 192 credits for the B Tech Degree program.

The A**dd on Proficiency Certification / Diploma** so issued to the candidate contains the courses studied and grades earned.

5. Scheme of Assessment and Evaluation

5.1. The Scheme of Assessment and Evaluation will have two parts, namely;

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

5.2. 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 40:60 marks respectively (i.e., 40 marks internal assessment; 60 marks semester end examination).

5.3. The 40 marks of internal assessment shall comprise of:

Internal Test	= 30 marks
Assignments / Seminars / Model Making etc.	= 10 marks

5.4. There shall be **three internal tests** conducted as per the schedule given below. **The students have to attend all the three tests compulsorily.**

- 1st test for 15 marks at the end of 6th week of the beginning of the semester;
- 2nd test for 15 marks at the end of 13th week of the beginning of the semester; and
- 3rd test for 15 marks at the end of 16th week of the beginning of the semester.

5.5. The coverage of syllabus for the said three tests shall be as under:

- For the 1st test syllabus shall be 1st unit and 1st half 2nd unit of the Course;
- For the 2nd test it shall be 2nd half of 2nd unit and 3rd unit of the Course;
- For the 3rd test the syllabus will be 4th unit of the Course.

5.6. Out of 3 tests, the highest marks scored in **two tests** are automatically considered while assessing the performance of the students.

5.7. There shall be two Assignments / Seminars each carrying 5 marks ; whereas the number of model designs and the marks for each model design shall be decided by the School well in advance and should be announced before commencement of the Semester to avoid ambiguity and confusion among students and faculty members.

5.8. The Semester End Examination for 60 marks shall be held in the 19th and 20th week of the beginning of the semester and the syllabus for the semester end examination shall be entire 4 units.

5.9. The **duration of the internal test shall be 75 minutes and for semester end examination the duration shall be 3 hours**.

5.10. Summary of Internal Assessment and Evaluation Schedule is provided in the table given below.

Summary of Internal Assessment and Evaluation Schedule

Type of Assessment	Period	Syllabus	Marks	Activity
Allocation of Topics for Assignments / Seminars / Model making*	Beginning of 5th Week	First Unit and Second Unit		Instructional process and Continuous Assessment
First Internal Test	2nd Part of 6th Week	First Unit and 1st half of Second Unit	15	Consolidation of 1st Unit 1st half of 2nd Unit
Submission of Assignments / Conduct of Seminars / Presentation of Model Design*	8th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Second Internal Test	2nd Part of 13th Week	Second half of Second Unit and Third Unit	15	Consolidation of Second half of Second Unit and 3rd Unit
Allocation of Topics for Assignments / Seminars / Model making*	Beginning of 11th Week	Third Unit and Fourth Unit		Instructional process and Continuous Assessment

Submission of Assignments / Conduct of Seminars / Presentation of Model Design*	14th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Third Test	2nd Part of 16th Week	Fourth Unit	15	Consolidation of Fourth Unit
Semester-end Practical Examination	17th & 18th Week	Entire syllabus	60	Conduct of Semester - end practical exams
Preparation for Semester-end Theory Exam	17th & 18th Week	Entire Syllabus		Revision and preparation for semester–end exam
Semester End Theory Examination	19th Week & 20th Week	Entire Syllabus	60	Consolidation of all Four Units, Examination, Evaluation and Tabulation
	End of 21st Week			Notification of Final Grades

Note: 1. **As per the model making is concerned, the School shall decide about the Marks and the Number of Model Designs and as well the schedule of allocation and presentation of model design(s). If the model design carries 5 marks, there shall be two model designs; and in case of 10 marks, there shall be one model design. However, the decision of the School should be announced in the beginning of the Semester for students to avoid ambiguity and confusion.*

2. Examination and Evaluation shall take place concurrently and Final Grades shall be announced latest by 5 day after completion of the examination.

3. Practical examination wherever applicable shall be conducted after 3rd test and before semester end examination. The calendar of practical examination shall be decided by the respective School Boards and communicated well in advance to the Registrar (Evaluation) who will notify the same immediately.

6. Assessment of Performance in Practicals

6.1. 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.

6.2. The 40 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	20 marks

	semester	
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.	10 marks
	Total	**40 marks**

63. The 60 marks meant for Semester End Examination (SEE), shall be allocated as under:

i	Conduction of semester end practical examination	40 marks
ii	Write up about the experiment / practical conducted	10 marks
iii	Viva Voce	10 marks
	Total	**60 marks**

6.4. The duration for semester-end practical examination shall be decided by the concerned School Board.

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

7.1. 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	Results of Work and Draft Report (25%)
Component– III	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%.

8. Provision for Appeal

If a candidate is not satisfied with the evaluation of Internal Assessment components (Mid-term Tests and Assignments), he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc, 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 taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

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

- The Registrar (Evaluation) - 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.

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

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

10. Requirements to Pass the Semester and to Carry Forward the Failed Subjects / Courses:

10.1 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 = 40 + SEE = 60) and have to secure a minimum of 40% to declare pass in the course. However, a candidate has to secure a minimum of 25% (15 marks) in Semester End Examination (SEE) which is compulsory.

10.2 Provision to Carry Forward the Failed Subjects / Courses:

The total number of "F" Grades that can be carried forward by a student at the end of any even semester **shall not be more than four courses**.

10.3. Re-Registration and Re-Admission:

a) 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 end semester examination and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

b) 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.

11. Attendance Requirement:

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

11.2. 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.

11.3. 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 as provided in 10.3.

11.4. Teachers offering the courses will place the above details in the School Board meeting during the last week of the semester, before the commencement of Semester end examination, and subsequently a notification pertaining to the above will be brought out by the Director of the School before the commencement of Semester end examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

11.5. Absence during Internal Test:

In case a student has been absent from a 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 Head of the School, for conducting a separate internal test. The Head 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.

12. Grade Card and Grade Point

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

12.2. 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 Registrar (Evaluation).

12.3. 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 > 90	9	v*9	A+
70 > 80	8	v*8	A
60 > 70	7	v*7	B+
55 > 60	6	v*6	B
50 > 55	5.5	V*5.5	C+
40 > 50	5	v*5	C
0-40	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.

12.3.1. 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	**4**	**A+**	**9**	**4X9=36**
Course 2	**4**	**A**	**8**	**4X8=32**
Course 3	**3**	**B+**	**7**	**3X7=21**
Course 4	**3**	**O**	**10**	**3X10=30**
Course 5	**3**	**C**	**5**	**3X5=15**
Course 6	**3**	**B**	**6**	**3X6=18**
Course 7	**2**	**O**	**10**	**2X10=20**
Course 8	**2**	**A**	**8**	**2X8=16**
	24			**188**

Thus, **SGPA = 188 ÷ 24 = 7.83**

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**

12.4. Cumulative Grade Point Average (CGPA):

12.4.1. Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (192) 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.

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

Illustration:

CGPA after Final Semester

Semester (ith)	No. of Credits (Ci)	SGPA (Si)	Credits x SGPA (Ci X Si)
1	24	6.83	24 x 6.83 = 163.92
2	24	7.29	24 x 7.29 = 174.96
3	24	8.11	24 x 8.11 = 192.64
4	26	7.40	26 x 7.40 = 192.4
5	26	8.29	26 x 8.29 = 215.54
6	24	8.58	24 x 8.58 = 205.92
7	24	9.12	24 x 9.12 = 218.88
8	24	9.25	24 x 9.25 =222
Cumulative	196		1588.26

Thus, **CGPA** = $\frac{24x6.83+24x7.29+24x8.11+26x7.40+26x8.29+24x8.58+24x9.12+24x9.25}{196}$ = 8.10

12.4.2. 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 8.10 x 10=81.0

12.5. 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) G	Letter Grade	Performance	FGP 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

Overall percentage=10*CGPA

13. **Challenge Valuation:**

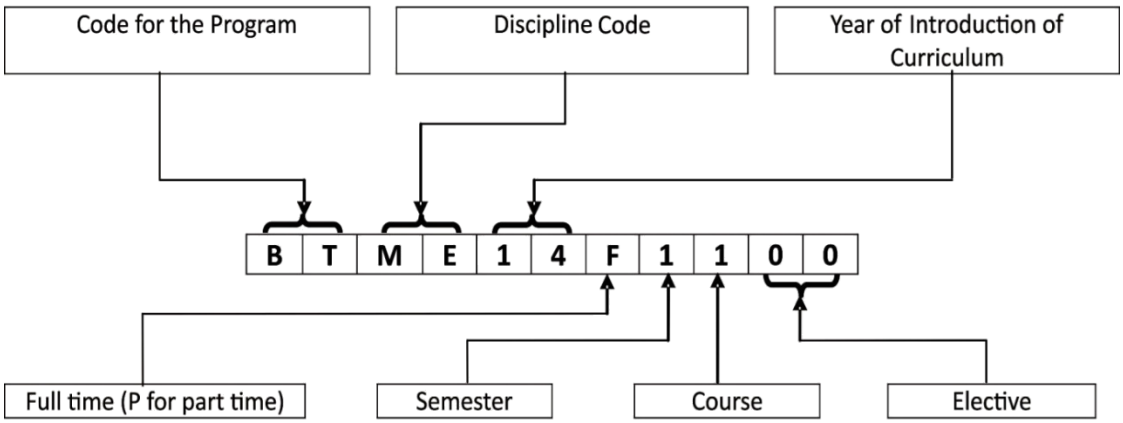
a. A student who desires to apply for challenge valuation shall obtain a photo copy of the answer

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 Registrar (Evaluation) within 10 days after the announcement of the results. **This challenge valuation is only for semester end examination.**

b. The answer scripts 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.

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

Course Numbering Scheme



List of Codes for Programs and Disciplines / Branch of Study

Program Code	Title of the Program	Discipline Code	Name of the Discipline / Branch of Study
BA	Bachelor of Arts	AE	Advanced Embedded Systems
BB	BBM (Bachelor of Business Management)	AI	Advanced Information Technology
BC	B.Com (Bachelor of Commerce)	AP	Advanced Power Electronics
BR	B. Arch (Bachelor of Architecture)	CA	Computer Aided Structural Engineering
BS	B Sc, BS (Bachelor of Science)	CE	Civil Engineering
BT	B.Tech (Bachelor of Technology)	CH	Chemistry
BP	Bachelor of Computer Applications	CO	Commerce
BL	LLB (Bachelor of Law)	CS	Computer Science and Engineering / Computer Science
MA	Master of Arts	DE	Data Engineering and Cloud Computing
MB	MBA (Master of Business Administration)	EC	Electronics and Communication Engineering
MC	M.Com (Master of Commerce)	EN	English
MS	M.Sc / MS (Master of Science)	MD	Machine Design and Dynamics
MT	M Tech (Master of Technology)	ME	Mechanical Engineering
MC	Master of Computer Applications	EE	Electrical & Electronics Engineering

B Tech in Mechanical Engineering

Scheme of Instruction (for 2017 Admitted Batch)

Scheme of Instruction

I Semester- CHEMISTRY CYCLE									
Sl No	**Course code**	**Title of the Course**	**HC/SC/OE**	**Credit Pattern & Credit Value**				**Contact Hrs/week**	**Teaching School/Dept**
				L	**T**	**P**	**Total**		
1	BTEM16F1100	Engineering Mathematics – I	HC	3	1	0	4	5	Mathematics
2	BTEC16F1200	Engineering Chemistry	HC	2	1	0	3	4	Chemistry
3	BTBE16F1300	Basic Electronics Engineering	HC	2	1	0	3	4	Electronics
4	BTCC16F1400	Computer Concepts & C Programming	HC	2	1	0	3	4	CSE
5	BTES16F1500	Environmental Sciences	FC	1	1	0	2	3	Civil
6	BTTE16F1600	Technical English-I	FC	0	0	2	2	4	Humanities
7	BTED16F1700	Computer Aided Engineering Drawing	HC	2	0	2	4	6	Mechanical
8	BTCL16F1800	Engineering Chemistry Lab	HC	0	0	2	2	3	Chemistry
9	BTCP16F1900	Computer Programming Lab	HC	0	0	2	2	3	CSE
Total Credits of the semester							**25**		

II Semester- PHYSICS CYCLE									
Sl No	**Course code**	**Title of the Course**	**HC/ SC/OE**	**Credit Pattern & Credit Value**				**Contact Hrs/week**	**Teaching School/Dept**
				L	**T**	**P**	**Total**		
1	BTEM16F2100	Engineering Mathematics – II	HC	3	1	0	4	5	Mathematics
2	BTEP16F2200	Engineering Physics	HC	2	1	0	3	4	Physics
3	BTCV16F2300	Elements of Civil Engineering	HC	2	1	0	3	4	Civil
4	BTME16F2400	Elements of Mechanical Engineering	HC	2	1	0	3	4	Mechanical
5	BTEE16F2500	Basic Electrical Engineering	HC	2	1	0	3	4	Electrical
6	BTIC16F2600	Indian Constitution and Professional Ethics	FC	1	1	0	2	3	Humanities
7	BTTE16F2700	Technical English-II	FC	0	0	2	2	3	Humanities
8	BTPL16F2800	Engineering Physics Lab	HC	0	0	2	2	3	Physics
9	BTEW16F2900	Workshop Practice	HC	0	0	2	2	3	Mechanical
Total Credits of the semester							**24**		

SL No	Course code	Title of the Course	HC/ SC/ OE	Credit Pattern & Credit Value				Contact Hrs./ week	Teaching School/ Dept
				L	T	P	Total		
THIRD SEMESTER									
1	BTME16F3100	Engineering Mathematics-III	HC	4	0	0	4	4	Maths
2	BTME16F3300	Strength of Materials	HC	3	1	0	4	5	ME
3	BTME16F3400	Basic Thermodynamics	HC	3	1	0	4	5	ME
4	BTME16F3500	Manufacturing Technology-I	HC	3	0	0	3	3	ME
Group A									
5	BTME16F3200A	Material Science and Metallurgy	HC	3	0	0	3	3	ME
6	BTME16F3600A	Computer Aided Machine Drawing	HC	1	0	2	3	5	ME
7	BTME16F3700A	Material Science Lab	HC	0	0	2	2	3	ME
8	BTME16F3800A	Manufacturing Technology Lab	HC	0	0	2	2	3	ME
Group B									
5	BTME16F3200B	Mechanical Measurements & Metrology	HC	3	0	0	3	3	ME
6	BTME16F3600B	Fluid Mechanics	HC	2	1	0	3	4	ME
7	BTME16F3700B	Metrology and Measurement Lab	HC	0	0	2	2	3	ME
8	BTME16F3800B	Machine Shop	HC	0	0	2	2	3	ME
Total Credits of the semester							**25**		
Note: Those who studied Group A courses in III sem must study Group B courses in IV semester; Those who studied Group B courses in III sem must study Group A courses in IV semester									
FOURTH SEMESTER									
1	BTME16F4100	Engineering Mathematics-IV	HC	4	0	0	4	4	Maths
2	BTME16F4300	Applied Thermodynamics	HC	3	1	0	4	5	ME
3	BTME16F4400	Theory of Machines-I	HC	3	1	0	4	5	ME
4	BTME16F4500	Manufacturing Technology-II	HC	3	0	0	3	3	ME
Group A									
5	BTME16F4200A	Material Science and Metallurgy	HC	3	0	0	3	3	ME
6	BTME16F4600A	Computer Aided Machine Drawing	HC	1	0	2	3	5	ME
7	BTME16F4700A	Material Science Lab	HC	0	0	2	2	3	ME
8	BTME16F4800A	Manufacturing Technology Lab	HC	0	0	2	2	3	ME
Group B									
5	BTME16F4200B	Mechanical Measurements & Metrology	HC	3	0	0	3	3	ME
6	BTME16F4600B	Fluid Mechanics	HC	2	1	0	3	4	ME
7	BTME16F4700B	Metrology and Measurement Lab	HC	0	0	2	2	3	ME
8	BTME16F4800B	Machine Shop	HC	0	0	2	2	3	ME

Total Credits of the semester							25		
FIFTH SEMESTER									
Sl No	**Course Code**	**Title of the Course**	**HC/SC**	**L**	**T**	**P**	**Total**	**Hrs/ Week**	**School**
1	BTME16F5300	Machine Design-I	HC	3	1	0	4	5	ME
2	BTME16F5400	Hydraulics & Pneumatics	HC	3	0	0	3	3	ME
3	BTME16F5500	Principles of Management	HC	3	0	0	3	3	ME
4	BTME16F5610	Internal Combustion Engine	SC	3	0	0	3	3	ME
	BTME16F5620	Processing of Materials in Manufacturing	SC						ME
	BTME16F5630	Statistical Quality Control	SC						ME
	BTME16F5640	Power Plant Engineering	SC						ME
Group A									
5	BTME16F5100A	Turbo Machinery	HC	3	1	0	4	5	ME
6	BTME16F5200A	Theory of Machines-II	HC	3	1	0	4	5	ME
7	BTME16F5700A	Fluid Machinery Lab	HC	0	0	2	2	3	ME
8	BTME16F5800A	Energy Conversion Lab	HC	0	0	2	2	3	ME
Group B									
5	BTME16F5100B	Finite Element Method	HC	3	1	0	4	5	ME
6	BTME16F5200B	Heat & Mass Transfer	HC	3	1	0	4	5	ME
7	BTME16F5700B	Computer Aided Modeling and Analysis Lab	HC	0	0	2	2	3	ME
8	BTME16F5800B	Heat & Mass Transfer Lab	HC	0	0	2	2	3	ME
Total Credits of the semester							**25**		
Note: (1) Those who studied Group A courses in V sem must study Group B courses in VI sem; Those who studied Group B courses in V sem must study Group A courses in VI sem; (2) Choose any ONE SC course among 4 SC courses given above.									
SIXTH SEMESTER									
1	BTME16F6300	CAD/CAM/CIM	HC	3	0	0	3	3	ME
2	BTME16F6400	Machine Design-II	HC	3	1	0	4	5	ME
3	BTME16F6510	Refrigeration & Air-conditioning	SC	3	0	0	3	3	ME
	BTME16F6520	Manufacturing Technology-III	SC						ME
	BTME16F6530	Production Planning & Control	SC						ME
	BTME16F6540	Theory of elasticity	SC						ME
4	BTME16F6610	Renewable Energy Resources	SC	3	0	0	3	3	ME
	BTME16F6620	Mechatronics and Microprocessor	SC						ME
	BTME16F6630	Industrial Engineering	SC						ME
	BTME16F6640	Experimental Stress Analysis	SC						ME
Group A									
5	BTME16F6100A	Turbo Machinery	HC	3	1	0	4	5	ME
6	BTME16F6200A	Theory of Machines-II	HC	3	1	0	4	5	ME
7	BTME16F6700A	Fluid Machinery Lab	HC	0	0	2	2	3	ME
8	BTME16F6800A	Energy Conversion Lab	HC	0	0	2	2	3	ME
Group B									
5	BTME16F6100B	Finite Element Method	HC	3	1	0	4	5	ME
6	BTME16F6200B	Heat & Mass Transfer	HC	3	1	0	4	5	ME
7	BTME16F6700B	Computer Aided Modeling and Analysis Lab	HC	0	0	2	2	3	ME

8	BTME16F6800B	Heat & Mass Transfer Lab	HC	0	0	2	2	3	ME
Total Credits of the semester							**25**		
Note: (1) Those who studied Group A courses in V sem must study Group B courses in VI sem; Those who studied Group B courses in V sem must study Group A courses in VI sem; (2) Choose any ONE SC course among 4 SC courses given above.									
SEVENTH SEMESTER									
Sl No	**Course Code**	**Title of the Course**	**HC/SC /OE**	**L**	**T**	**P**	**Total**	**Hrs/ Week**	**School**
1	BTME16F7100	Control systems	HC	2	1	0	3	4	ME
2	BTME16F7200	Mechanical Vibrations	HC	2	1	0	3	4	ME
3	BTME16F7300	Operation Research	HC	2	1	0	3	4	ME
4	BTME16F7410	Cryogenic Engineering	SC	4	0	0	4	4	ME
	BTME16F7420	Product Design and Development	SC						ME
	BTME16F7430	Engineering economics & Financial Management	SC						ME
	BTME16F7440	Theory of plasticity	SC						ME
5	BTME16F7510	Computational Fluid Dynamics	SC	3	0	0	3	3	ME
	BTME16F7520	Nano Technology and Applications	SC						ME
	BTME16F7530	Tribology & Bearing Design	SC						ME
	BTME16F7540	Automation in Manufacturing	SC						ME
6	BTME16F7610	**Open elective-**Industrial automation and production system	OE	4	0	0	4	4	ME
	BTME16F7620	**Open elective-**Industrial Engineering							
7	BTME16F7700	CIM & Automation Laboratory	HC	0	0	2	2	3	ME
8	BTME16F7800	Design Laboratory	HC	0	0	2	2	3	ME
Total Credits of the semester							**24**		
Note: (1) Choose any ONE SC course among 4 SC courses given above; (2) The above OE courses are offered to students of other Schools and the students of Mechanical Engineering have to take the OE courses offered by other Schools									
EIGHTH SEMESTER									
1	BTME16F8100	Safety Measures in Mechanical Engineering	HC	3	0	0	3	3	ME
2	BTME16F8210	Automotive Engineering	SC	4	0	0	4	4	ME
	BTME16F8220	Robotics	SC						ME
	BTME16F8230	Project Management	SC						ME
	BTME16F8240	Mechanics of Composite Materials	SC						ME
3	BTME16F8310	Biomass Energy Systems	SC	4	0	0	4	4	ME
	BTME16F8320	Rapid Prototyping	SC						ME
	BTME16F8330	Non Destructive Testing Methods	SC						ME
	BTME16F8340	Machine Tool Design	SC						ME
4	BTME16F8400	Major Project	HC	0	0	8	8	-	ME
Total Credits of the semester							**19**		
Total Credits of First to Eighth Semesters							**192**		
Note: (1) Choose any ONE SC course among 4 SC courses given above.									

B Tech in Mechanical Engineering

Detailed Syllabus

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTEM16F1100	**Engineering Mathematics – I**	16	HC	3	1	0	4	5

Prerequisites: Knowledge of limits, continuity, differentiation, integration, matrices, determinants, and geometry.	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

FIRST SEMESTER

Course Objectives:

1. Learn the concept of polar coordinate system and its application to engineering problems.
2. To understand the concepts of differential calculus and its application.
3. To familiarize with partial differentiation and its application in various field.
4. Learn to solve analytically the first order first degree differential equation.
5. Learn the concept of integration of functions of two/three variables over a region.
6. Learn to integrate improper integrals using Beta and Gamma function

Course Outcomes:

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

1. Find the angle between polar curves, express the polar curve in terms of pedal form.
2. Determine radius of curvature and able to determine limits of indeterminate function applicable to already word problems and engineering problems.
3. Use partial differentiation to find the derivatives of implicit and composite functions.
4. Check functional dependence using jacobians. Learn to expand any functions of two variables in ascending power and to find the extremum value of a given function related to engineering problems and gain knowledge to solve differential equation arising in different engineering branch
5. Recognize and solve first order ordinary differential equation
6. Learn the evaluation policy of some special functions like beta and gamma functions and their relation which is helpful to evaluate some definite integral arising in various branch of engineering.

Course Contents:

UNIT-I: Differential Calculus-I **[14hrs]**

Successive differentiation-nth derivatives (proof and problems),Leibnitz Theorem (without proof) and problems, Taylors series and Maclaurins series expansion for one variable(only problems), Polar curves- Angle between the radius vector tangent, angle between two curves, Pedal equation for polar curves.

UNIT-II: Differential Calculus-II **[16hrs]**

Derivative of arc length – concept and formulae without proof, Radius of curvature-Cartesian, parametric, polar and pedal forms(without proof) problems. Indeterminate forms and solution using L'Hospital's rule.

Partial Differentiation: Partial derivatives-Euler's theorem-problems, Total derivative and chain rule.

UNIT-III: Differential Calculus-III and Differential Equations **[14hrs]**

Jacobians-definition and problems (only find *J* and*reference- one example on =1). Taylor's Expansion of function of two variables(only problems- up to 2nd order).Maxima and Minima for a function of two variables (simple problems).Exact equation and reducible to exact form(1. Close to expression M or N and find IF, 2. y f(x) dx+x g(y) dy)

UNIT-IV: Integral Calculus **[14hrs]**

Reduction formulae for the integrals of ,, and evaluation of these integrals with standard limits(direct result) - Problems.

Multiple Integrals – Double integrals, change of order of integration (simple problems), and triple integrals. Beta and Gamma functions (definition),(properties and duplication formula -without proof), Relation between beta and gamma function and simple problems.

Text books:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43nd edition, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th edition, 2013.

Reference Books:

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th Reprint edition, 2013.
2. R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 4th edition, 2016.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTEC16F1200	**Engineering Chemistry**	16	HC	2	1	0	3	4
Prerequisites: Basic knowledge of Chemistry		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

Engineering chemistry covers the very basic knowledge required for engineering students to understand its importance in technology. All the branches directly or indirectly deal with the principles of chemistry, for example;

1. Cell and Batteries deals with basic principles, types of electrodes and their importance in some applications and materials required for designing and proper functioning of batteries.
2. Corrosion and metal finishing, explains why and how materials corrode and its prevention. It also covers the importance of metal finishing in various industries and fabrication of PCB
3. Polymers are all about the properties of various polymeric materials and their commercial significance. The chapter reveals about technical and commercial importance of composite materials.

Course Outcomes:

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

1. The importance of electrodes and materials in designing a battery
2. Corrosion phenomenon and precautions to be taken in the selection of materials in controlling corrosion
3. Fabrication of PCB, an important component for electronic industries
4. Properties of polymers and their applications in various field, also that of composite materials in sports, aviation etc.,

Course Contents:

UNIT - 1 **[11 hrs]**

Cells and Batteries : Introduction to electrochemistry, Basic concepts, Battery characteristics – primary, secondary and reserve batteries, Super capacitors, Lithium batteries.Fuel cells-Difference between battery and fuel cell, types of fuel cells- construction working, applications, advantages& limitations of Solid oxide fuel cells and phosphoric acid fuel cell.Photovoltaic cell-Production of single crystal semiconductor by Crystal pulling technique (Czocharlski method), zone refining of si, antireflective coatings, Construction and working of photovoltaic cells and its applications and advantages using elemental si and semiconductors.

UNIT - 2 **[10hrs]**

Corrosion & its control& metal finishing: Introduction to Electrochemical theory of corrosion, Galvanic series Types of Corrosion- Differential metal corrosion Differential aeration corrosion(Pitting & water line),Stress corrosion (Caustic embrittlement), and Grain boundary corrosion, Factors affecting rate of corrosion-Primary, secondary, pilling bed worth role, Energy concept (Pourbiax) under different pH conditions. Corrosion Studies on Al, Fe with phase diagram Corrosion control: Inorganic coating -Anodizing & Phosphating, metal coating- galivanzing& tinning, cathodic protection, Anodic Protection. Role of secondary reference electrode in corrosion studies (calomel ,Ag/AgCl)

Metal Finishing-Technological importance, significances of polarization. Decomposition potential & overvoltage in electroplating, theory of electroplating. Effect of plating variables on the nature of electrodeposit- electroplating process, Electroplating of gold, Introduction to Electro less plating-Cu.

UNIT - 3 **[11 hrs]**

Introduction to Nano science and Nanotechnology: Introduction to Nanomaterials, Properties – optical, electrical, magnetic and thermal .Chemical synthesis of Nanomaterials – sol gel (MOx NPs), phase transfer method (Au NPs). Carbon Nanomaterials-Fullerenes, graphene, CNT. Applications of nano materials- nano catalysis, nano-electronics, energy conversion materials (in batteries, solar cells), nano sensors.Introduction to electromagnetic spectrum-material analysis, Instrumentation-principle, working and applications of UV-Visible, XRD, SEM.

UNIT - 4 **[10 hrs]**

Polymers: Introduction, Types of polymerization-Addition and Condensation, Ziegler's Natta catalyst, molecular weight determination by viscosity method, glass transition temperature, Structure and Property relationship. Synthesis &Applications of -Bakelite, ABS, Nylon6,6, PMMA.
Adhesives-Synthesis and applications of epoxy resins, Polymer composites- Synthesis and applications of Kevlar and Carbon fibers, Conducting polymers-Definition, Mechanism of conduction in polyacetylene , Synthesis & applications of conducting Polyaniline, Polymer liquid crystals, Biopolymers, Polymer membranes-ion exchange & ionic conductivity.

Recommended Learning Resources

1. Engineering chemistry by R.V. Gadag and Nithyanandashetty, IkInteranationalPudlishing house
2. Engineering chemistry by R.Venugopal, Pushpaiyengar, B.S. Jayaprakash and Shivakumariah Subhash Publications
3. Polymer chemistry by V.R. Gowrikar, N.N. Vishwanathan and J. Sreedhar by Wiley eastern ltd.
4. Corrosion engineering by M.G. Fontana, Tata Mcgrahill Publishing pvt. Ltd
5. Introduction to Nanotechnology by Charles P. Poole Jr., Frank J. Owens Wiley India Publishers.
6. Theory and practice in applied chemistry by O.P. Vermani and Narulla, New age international publications

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTEC16F1300	**Basic Electronics Engineering**	16	HC	2	1	0	3	4
Prerequisites: Basic Physics		Internal Assessment		Semester End Exam				
		40 Marks		60 Marks				

Course Objectives:

1. To familiarize with the number systems, Boolean algebra and digital circuit design.
2. To understand the diode characteristics and its applications.
3. To learn the working principles of various electronic circuits.
4. To understand the transistor characteristics and its applications.
5. To compare the different biasing methods of transistors.
6. To understand the working of amplifiers and communication systems.

7. To understand the power electronic devices.

Course Outcomes:

On completion of this course the student will be able to:

1. Design the digital circuits using various logic gates.
2. Analyze various diode circuits.
3. Work on various application based on electronic instruments.
4. Design of amplifier circuit based on BJT.
5. Demonstrate the working of amplifiers and the oscillators.
6. Analyze the various communication techniques.
7. Design Zener voltage regulator.

Course Contents:

Unit 1: Digital Electronics and Number Systems [11hrs]

Digital Electronics: Introduction, Switching and Logic Levels, Digital Waveform. Number Systems: Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System.

Number base conversions: Binary to Decimal, Decimal to Binary, Binary to Octal, Octal to Binary, Binary to Hexadecimal, Hexadecimal to Binary, Decimal to Octal, Octal to Decimal, Decimal to Hexadecimal, Hexadecimal to Decimal, Octal to Hexadecimal, Hexadecimal to octal. Complement of Binary Numbers. Binary addition, binary subtraction. Boolean Algebra Theorems, De Morgan's theorem. Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, NAND Gate, NOR Gate, XOR Gate, XNOR Gate. Algebraic Simplification, NAND and NOR Implementation NAND Implementation, NOR Implementation. Half adder and Full adder Implementations.

Unit 2: Semiconductor Diodes and Applications [11hrs]

p-n junction diode, Characteristics and Parameters, Diode approximations, DC load line analysis, Half-wave rectifier, Two-diode Full-wave rectifier, Bridge rectifier, Capacitor filter circuit, Zener diode voltage regulators: Regulator circuit with no load, Loaded Regulator. Numerical examples as applicable.

Unit 3: Bipolar junction Transistors [12hrs]

BJT configuration: BJT Operation, BJT voltages and currents, BJT amplification, Common Base, Common Emitter and Common Collector Characteristics, Numerical examples as applicable.

BJT Biasing: DC load line and Bias Point, Base Bias, Voltage divider Bias, Numerical examples as applicable.

Unit 4: Electronic Devices and Applications [8hrs]

SCR, controlled rectifier-full bridge type. Oscillators and applications. OPAMP-summer, subtractor, integrator and differentiator, and typical applications in measurements.

Communication system, embedded system, cellular communication, satellite communication, remote sensing. (Block diagram approach).

Text Books :

1. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 2008.
2. D.P. Kothari, I. J. Nagrath, "Basic Electronics", McGraw Hill Education (India) Private Limited, 2014.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTCC16F1400	**Computer Concepts and C Programming**	16	HC	2	1	0	3	4

Prerequisites: Basic Knowledge of computer	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

The objective of this course is to:

1. Introduce the fundamentals of computer System;
2. Provide an understanding of problem solving with computers;
3. Introduce C programming language;
4. Provide a familiarization with the Unix programming environment;
5. Introduce problem solving through authoring and executing C programs.

Course Outcomes:

A student who successfully completes the course will have the ability to:

1. Use the basic terminology of computer programming;
2. Explain the different Unix commands, their usage and their syntax;
3. Write, compile and debug programs in C language;
4. Use different data types and operators in a computer program;
5. Design programs involving decision structures, loops and functions;
6. Use procedure calls by value and by reference;
7. Use arrays in applications like sorting and searching;
8. Handling strings;
9. Apply the C language knowledge to solve variety of problems.

Course Contents:

UNIT- 1: **[12hrs]**

Introduction to Computer System: Definition of Computer, Structure of a computer, Basics of computer hardware and computer software, Types and Functions of operating system. Algorithms and Flow charts.

Getting started with UNIX: Introduction to Unix Operating System, Introduction to Basic Command Format, Using the VI text editor, Basic UNIX commands, Types of computer networks.

UNIT- 2: **[11hrs]**

Fundamentals of Problem Solving and Introduction to C Language: Introduction to C Language –Structure of a C Program, Data type, Variables, Constants, Input / Output, Tips and common programming errors.

Operators: Types of Operators, Expressions and Statements.

Branching constructs: Conditional Branching- if, if-else, else-if ladder, nested if, switch. Unconditional- goto, break, continue, return.

UNIT- 3: **[11hrs]**

Looping constructs: for, while, do- while, nested-for, Advantages of Looping.

Arrays: One Dimensional and Two Dimensional Arrays; Searching Techniques, Sorting-bubble sort;

UNIT 4: **[8hrs]**

Functions: Inbuilt and User defined Functions, Parameter Passing mechanisms, Call by value and Call by address;

Strings: String Operations with and without using inbuilt String Functions;

Pointers: Introduction to Pointers.

Recommended Learning Resources:

1. Herbert Schildt, C: The Complete Reference, 4th Edition, Tata McGraw Hill
2. Kernighan, Dennis Ritchie, The C Programming Language ,2nd edition, Englewood Cliffs, NJ: Prentice Hall, 1988
3. Sumitabha Das, UNIX Concepts and Applications, 4th Edition; Tata McGraw Hill
4. B.S. Anami, S.A. Angadi and S. S. Manvi, Computer Concepts and C Programming*: A Holistic Approach, PHI, Second Edition, 2008.*
5. E. Balaguruswamy, Programming in ANSI C, 4th Edition, Tata McGraw Hill, 2008.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTES16F1500	**Environmental Science**	16	FC	1	1	0	2	3
Prerequisites: Chemistry		Internal Assessment		Semester End Exam				
		40 Marks		60 Marks				

Course Objectives:

The objectives of this course are to:

1. Gain knowledge on the components of environment and importance of environmental studies.
2. Understand the various types of energy and natural resources.
3. Acquire knowledge with respect to biodiversity, its threats and its conservation and appreciate the concept of ecosystem.

4. Get knowledge about environmental pollution-sources, effects and control measures of environmental pollution.
5. Explore ways for protecting the environment.

Course Outcomes:

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

1. Analyze the environmental conditions and protect it.
2. Find new renewable energy resources.
3. Analyze the ecological imbalances and protect it.
4. List the causes of environmental pollution.
5. Design pollution controlled products.

Course Contents:

UNIT - 1 **[7 Hrs]**

Introduction: Basic definitions, Objectives and Guiding principles of Environmental Studies, Components of Environment, Structures of atmosphere, Man-Environment relationship, Impact of Technology on the environment, sustainable environment, Environmental Protection - Role of Government, Initiatives by Non - Governmental Organizations (NGO)**.**

UNIT - 2 **[8 Hrs]**

Energy & Natural Resources: Energy - Different types of energy, Electro-magnetic radiation. Conventional and Non-Conventional sources - Hydro Electric, Fossil fuel based, Nuclear, Solar, Biomass and Bio-gas. Hydrogen as an alternative future source of Energy, Natural Resources- Water resources, Mineral Resources, Forest Wealth.

UNIT - 3 **[6Hrs]**

Ecology & Ecosystems: Ecology- Objectives and Classification, Concept of an ecosystem - structure & function, Balanced ecosystem, Components of ecosystem - Producers, Consumers, Decomposers, Bio-Geo- Chemical Cycles & its Environmental significance (Carbon Cycle and Nitrogen Cycle), Energy Flow in Ecosystem, Food Chains: Types & Food webs Ecological Pyramids.

UNIT - 4 **[7 Hrs]**

Environmental Pollution: Introduction, Types, Concepts -Air Pollution, Water Pollution& Noise Pollution. Environmental Degradation- Global Warming, Green Houses Effects, Acid Rain, and Depletion of Ozone Layer.

Recommended Learning Resources

1. Benny Joseph (2005), "Environmental Studies", Tata McGraw – Hill Publishing Company Limited
2. Meenakshi P. (2006), "Elements of Environmental Science and Engineering", Prentice Hall of India Private Limited, New Delhi

3. Rajagopalan R. (2005), "Environmental Studies – From Crisis to Cure", Oxford University Press

Reference Books:

1. Raman Sivakumar, (2005), "Principles of Environmental Science and Engineering", Second Edition, Cengage learning, Singapore
2. Ranjit Daniels R.J. and JagdishKirshnaswamy, (2009), "Environmental Studies", Wiley India Private Ltd., New Delhi
3. Prakash S.M. (2007), "Environmental Studies", Elite Publishers, Mangalore
4. ErachBharucha (2005), "Text Book of Environmental Studies", for UGC, University Press
5. Tyler Miller Jr. G. (2006), "Environmental Science – Working with the Earth", Eleventh Edition, Thomson Brooks/Cole

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTTE16F1600	**Technical English-I**	16	FC	0	0	2	2	4
Prerequisites: Basic English		Internal Assessment: 40 Marks			Semester End Exam: 60 Marks			

Course Outline:

This is a four-credit course for two semesters consisting of 4 hours of teaching learning per week, inclusive of direct classroom teaching and practice in language lab.

Course Objectives:

1. To enable learners of Engineering and Technology develop their basic communication skills in English.
2. To emphasize specially the development of speaking skills amongst learners of Engineering and Technology.
3. To ensure that learners use the electronic media such as internet and supplement the learning materials used in the classroom.
4. To inculcate the habit of reading and writing leading to effective and efficient communication.

Course Outcomes:

On completion of the course, learners will be able to:

1. listen/view and comprehend different spoken discourses/excerpts in different accents.
2. speak clearly, confidently, comprehensibly, and communicate with one or many listeners using appropriate communicative strategies.
3. read different genres of texts adopting various reading strategies.
4. write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.

Course Contents:

UNIT - 1 **[16 hrs]**

Communicative Skills & Functional English: Basics of Communication, Verbal & Non-verbal Communication, Barriers to Effective Communication, Strategies of Effective Communication, Tenses, Conditional Sentences, Auxiliaries (Modal & Primary).

UNIT - 2 **[16 hrs]**

Listening & Reading Skills: . Definitions (Listening & Reading), Types of Listening, Barriers to Effective Listening, Traits of a Good Listener, Types of Reading, Techniques of Effective Reading, Reading Tasks (Critical & Inferential).

UNIT - 3 **[16 hrs]**

Academic Writing – I: Paragraphs, Notice/ Agenda/ Minutes, Note Taking/ Note Making Summarizing, Project Reports.

UNIT - 4 **[16 hrs]**

ICT/ Digital/ E-Skills: Computer Assisted Language Learning (CALL), Mobile Assisted Language Learning (MALL), Emails, Blogs, Digital/ E-Portfolio, Filling Online Application Forms

1. Murphy,Raymond.(1998), Intermediate English Grammar,New York
2. Wren &Martin (2001),English Grammar & Composition, New York
3. Mudambadithaya G.S.,(2002) English Grammar and composition
4. Digne, Flinders and Sweeney(2010) Cambridge University press
5. Lupton, Mary Jane (1998). *Maya Angelou: A Critical Companion*. Westport, Connecticut: Greenwood Press. ISBN 978-0-313-303225.
6. Booher, Diana. (2004),*Booher's Rules of Business Grammar*, OUPUr, Penny .(2002),*Grammar Practice Activities*, OUP
7. Wren &Martin (2001),*English Grammar & Composition*, New York

8. Joan Van Emden and Lucinda Becker Palgrave. Effective Communication for Arts and Humanities Students. Macmillan.Glendinning, Eric H. and Beverly Holmstrom (2008), Study Reading: A Course in Reading Skills for Academic Purposes, New Delhi: CUP.Langan, John (1996). College Writing Skills. McGraw Hills

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTED16F1700	**Computer Aided Engineering Drawing**	16	HC	2	0	2	4	6

Prerequisites: Basic Knowledge on geometry and their construction	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1 Comprehend general projection theory, with emphasis on orthographic projection to represent in two-dimensional views (principal, auxiliary, sections).
2 Dimension and annotate two-dimensional engineering drawings.
3 Understand the application of industry standards and best practices applied in engineering graphics.
4 Emphasize freehand sketching to aid in the visualization process and to efficiently communicate ideas graphically.
5 Introduction of CAD software for the creation of 2D engineering drawings.
6 The theoretical concepts delivered in this course would help the students to understand the sign considerations and tolerances to be used in the design and manufacture of engineering components.
7 This course will be very much basics for students to learn and wisely apply for the advanced Computer Aided Engineering (CAE) tools such as ABAQUS, ANSYS etc.

Course Outcomes:

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

1. Be industry ready and able to develop independent thinking and problem solving capabilities
2. Be able to express component descriptions as per the commonly practiced standards
3. Be able to produce 2D and simple 3D drawings
4. Be able to comprehend industry specific drawings
5. Be able to converse through computer aided drawing any Objects/tools/instruments /elements/ structures belonging to the entire engineering field
6. Be able to produce simple clear and illustrative drawings as per existing standards/conversations.

Course Contents:

UNIT - 1 **[18Hrs]**

Introduction to Drawing: Introduction to Engineering Drawing: Introduction, Drawing Instruments and their uses, BIS conventions, Drawing sheets, Dimensioning, , regular polygons and their construction.

Introduction to Software (solid edge): Computer screen, layout of the software, standard tool bar/menus and description of most commonly used tool bars, navigational tools Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend to next ,split, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination and perpendicularity. Dimensioning, line conventions, material conventions and lettering.

Orthographic Projection: Projection – Orthographic Projection – Planes of Projection – Four quadrants – First-angle projection – Third-angle projection – Reference line – Conventions employed.
Projection of points: Points in different quadrants.

Projection of Straight Lines (First-angle Projection only): Parallel to one or both planes – Perpendicular to one plane and parallel to other plane – Inclined to one plane and parallel to the other – Inclined to both planes.

Projection of Planes: Types of Planes, Projection of Planes - Parallel to one Plane and perpendicular to other planes – perpendicular to one and inclines to other – Inclined to both the planes.

UNIT - 2 **[18 Hrs]**

Projection of Solids: Polyhedron (Cube – Tetrahedron - Prisms and Pyramids) – Solids of revolution (Cone and Cylinder) – Solids in simple position – Axis perpendicular to a plane – Axis parallel to both planes – Axis parallel to one plane and inclined to the other – Axis inclined to both plane (only change of position method).

UNIT - 3 **[17Hrs]**

Sections of Solids: Section Planes – Sections – True Shape of Section – Sections of Prisms – Sections of Pyramids – Sections of Cylinders – Section of Cones.

Developments of Lateral Surfaces of Solids - Polyhedra (Cube – Tetrahedron - Prisms and Pyramids) – Solids of revolution (Cone and Cylinder) and their Frustums.

UNIT - 4 **[17Hrs]**

Isometric Projection : Isometric axes - Lines and Planes – Isometric Scale – Isometric Projection of Planes – Prisms – Pyramids – Cylinders – Cones – Spheres - Hemi-Spheres - frustums - Combination of Solids (Maximum Three).

Recommended Learning Resources

Text Books:

1. Engineering Drawing – N.D.Bhatt and V.M. Panchal, 48th Edition, 2005 – Charotar Publishing House, Gujarat.
2 Engineering Graphics - K.R. Gopalakrishna, 32nd Edition, 2005 – Subhas Publishers, Bangalore

Reference Books:

1. Engineering Drawing – P. S. Gill, 11th Edition, 2001 – S. K. Kataria& Sons, Delhi.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTCL16F1800	**Engineering Chemistry Lab**	16	HC	0	0	2	2	3
Prerequisites: Basic Chemistry		Internal Assessment		Semester End Exam				
		20 Marks		30 Marks				

Course Objectives:

To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence

Course Outcomes:

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

1. Handle different types of instruments for analysis of materials for better accuracy and precision
2. Carryout different types of titrations for quantitative estimations of materials.

Course Contents:

LAB EXERCISES

1. Potentiometric estimation of FAS using standard $K_2Cr_2O_7$
2. Conductometric estimation of an acid mixture using standard NaOH solution
3. Determination of pKa of a weak acid using pH meter
4. Determination of molecular weight of given polymer sample using ostmail's Viscometer
5. Colorimetric estimation of copper
6. Determination of COD of the given industrial waste water sample
7. Determination of total and temporary hardness of water using disodium salt of EDTA
8. Estimation of alkalinity of given water sample using standard HCl solution.
9. Determination of Iron in the given hematite ore solution using potassium dichromate
10. Determination of calcium oxide in the given sample of cement by rapid EDTA method
11. Flame photometric estimation of sodium in the given sample of water
12. Electroplating of copper and nickel

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTCP16F1900	**Computer Programming Lab**	16	HC	0	0	2	2	3
Prerequisites: Computer concepts		Internal Assessment			Semester End Exam			
		20 Marks			30 Marks			

Course Objectives:

The objectives of this course are to:

1. Introduce the Basic Principles of Problem Solving using a Computer;
2. Present and Provide the Programming Constructs of 'C' Programming Language;

3. Provide the skills required to Design, Demonstrate and Implement Computable Problems / Mini-projects / Projects using 'C' Programming Language;
4. Provide the Arena for Development of Analytical, Reasoning and Programming Skills;
5. Set the Strong Foundation for Software Development in the field of Programming and hence to Create high quality 'C' Professionals.

Course Outcomes:

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

1. Understand the Basic Principles of Problem Solving;
2. Study, understand and identify the Representation of Numbers, Alphabets and other Characters in the memory of Computer System;
3. Understand Analyze, Integrate, Apply and Demonstrate Software Development Tools; like Algorithms, Pseudo Codes and Programming Structures;
4. Study, Understand, Analyze and Categorize the logical structure of a Computer Program, and hence to Apply different programming constructs to develop a Computer Program using 'C' Programming Language;
5. Offer Engineering Solutions to simple (moderate) mathematical and logical problems using 'C' Programming Language;
6. Study, Understand, Analyze, Integrate, Classify, Compare and Apply simple Data Structures, Pointers, Memory Allocation and Data Handling through files using 'C' Programming Language;
7. Understand and identify the working of different Operating Systems; like Windows and Linux;
8. Enhance their Analytical, Reasoning and Programming Skills;

Lab Experiments:

1 a) Program to print the name, college name, Address of a student.
b) A company for aadhar card want's to collect its employees information. Write a program to take input of employee name and age.

2 Program to read and print the size of variables of different data type.

3 Arithmetic operations are widely used in many programs. Write a program to perform addition, subtraction, multiplication, modulo division, and division operations.

4 A person has deposited some amount in bank. Write a program to calculate simple interest and compound interest on amount for a period.

5 In Delhi, four wheelers run on the basis of even or odd number. Write a program to identify whether vehicle registration number is even or odd.

6 People frequently need to calculate the area of things like rooms, boxes or plots of land where quadratic equation can be used. Write a program to find the coefficients of a quadratic equation and compute its roots.

7 Consider the age of 3 persons in a family, Write a program to identify the eldest person among three of them.

8 Consider student's marks in Computer Test. Write a Program display the grade obtain by student in Computer Test based on range.

9 Calculator allows you to easily handle all the calculations necessary for everyday life with a single application. Write a program to design a basic calculator that performs the basic operations and you want to give choice to user to perform

a. Addition of two numbers, Subtraction of two numbers

b. Multiplication of two numbers, Division of two numbers, Wrong choice

10 In a stock market at the end of the day we do the summation of all the transactions.
   a. Write a program to display numbers (transactions) from1 to n.
   b. Write a program to find the sum of n natural numbers.

11 **Read your ATM Pin Number. Write a program to identify your Pin Number is palindrome or not.**

12 Read your Landline Number. Write a program to print the reverse of it and also find sum of digits of your Landline Number.

13 Create a Contact list of n friends, Write a program to read and print the Phone number of your friend's.

14 In computer based applications, matrices play a vital role in the projection of three dimensional image into a two dimensional screen, creating the realistic seeming motions. Write a program to perform matrix Multiplication and check compatibility of matrix.

15 You have joined a startup company of N employees; Write a program is to sort all employee id.

16 A student has taken 10 books from the library. Every time he take's the book, Librarian read's its ISBN Number. Write a program to identify whether book is issued to him or not based on ISBN Number.

17 Suppose students have registered for workshop, and their record is maintained in ascending order based on student id. Write a program to find whether a particular Student has registered for that particular workshop or not.

18 In a CCP test you scored less marks compared to your friend, Write a program to swap your marks with your friend.

19 In a memory game, you first enter a string wait for a time and again enter second string, Write a program to check both sting were same or not.

20 Read your first and last name in two different strings; Write a program to combine these two strings into third string.

21 Assume a person has entered a Password ,Write a program so that he can know the length of his password,

22 Read a meaningful word in English, Write a program to identify the word when inversed yields the same or not.

Recommended Learning Resources:

1. Herbert Schildt, C: The Complete Reference, 4th Edition, Tata McGraw Hill
2. Sumitabha Das, UNIX Concepts and Applications, 4th Edition; Tata McGraw Hill
3. ReemaThareja, Computer fundamentals and programming in C.
4. Kernighan, Dennis Ritchie, The C Programming Language ,2nd edition, Englewood Cliffs, NJ: Prentice Hall, 1988
5 .http://c-faq.com/index.html
1. Paul Deitel, C How to Program, 7th Edition, Deitel How to Series.
2. B.S. Anami, S.A. Angadi and S. S. Manvi, Computer Concepts and C Programming*: A Holistic Approach, PHI, Second Edition, 2008.*

SECOND SEMESTER:

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTEM16F2100	**Engineering Mathematics – II**	16	HC	3	1	0	4	5
Prerequisites: Knowledge of basics of derivatives, vectors, complex numbers		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To understand the concepts of Linear algebra and its applications in various fields of engineering and Technology.
2. To understand the concepts of Integral calculus and its applications.
3. To familiarize with partial differential equations, and its applications to standard problems like Heat, Wave and Laplace.
4. To impart the Knowledge of Laplace transforms and its applications in the field of engineering.

Course Outcomes:

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

1. Apply the knowledge of Linear Algebra in Image processing and digital signal processing.
2. Apply analytical techniques to compute solutions of first and higher order ordinary differential equations.
3. Apply the knowledge of partial differential equations in the field of signals and systems, control systems, magnetic wave theory.
4. Apply the knowledge of Laplace transformation from the time domain to the frequency domain, which transforms differential equations into algebraic equations and convolution into multiplication.
5. Find tangential and normal component of a vector, identify solenoidal and irrotational vectors, solve problems using vector identities.
6. Exhibit the interdependence of line, surface and volume integrals using integral theorems

Course Contents:

UNIT-I: Linear Algebra **[14hrs]**

Rank of matrix, Echelon form, (*reference-Normal form: one example), Solution of a system of linear equations by Gauss elimination (*reference-Gauss –Jordan methods: one example), Gauss seidel iterative method, Rayleigh Power method to find the largest eigen value and corresponding eigen vector.LU decomposition, Linear and Inverse transformation. Diagosnalisation of a matrix, Reduction of a quadratic form to canonical form by orthogonal transformation.

UNIT-II: Differential Equations: **[14hrs]**

Linear Differential Equations: Definitions, Complete solution, Operator D, Rules for finding the complementary function, Inverse operator, Rules for finding the particular integral.

Method of variation of parameters(simple problems), Cauchy's and Legendre's linear differential equations.

Partial differential equation: Formation of Partial differential equations, Solution of Lagranges linear PDE.

UNIT-III: Vector Calculus **[14hrs]**

Curves in space, tangents and normal, Velocity and acceleration related problems, scalar and vector point functions-Gradient, Divergence and curl, directional derivatives.Solenoidal and irrotational vector fields.Vector identities-div(), curl(), curl(grad), div(curl A).

Line integral-Circulation-work,Surface integral: Green's Theorem, Stokes Theorem.

Volume integral: Divergence theorem.(all theorems without proof, no verification, only evaluation).

UNIT-IV: Laplace Transforms: **[14 hrs]**

Definition, Transforms of elementary functions, properties of Laplace Transforms(without proof)problems.Transforms of periodic functions (only statement and problems), Unit step functions and unit impulse functions.

Inverse Laplace transforms- Problems, convolution theorem(without proof)- verification and problems, solution of linear differential equation using Laplace transforms.

Text books:

1 B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43nd edition, 2015.

2 Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th edition, 2013.

Reference Books:

1 B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th Reprint edition, 2013.

2 R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 4th edition, 2014.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTEP16F2200	**Engineering Physics**	16	HC	2	1	0	3	4
Prerequisites: Basic knowledge in physics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

The objectives of this course are to:

1. To provide the students the fundamentals of Physics and make their basic foundation in engineering education very strong.

2. To expose the students of different branches of engineering with a theoretical and practical knowledge of Engineering Physics
3. To prepare students and make them ready to take up higher semester core engineering subjects by giving them strong physics background.
4. Students should be getting knowledge of different physical systems, basic quantum mechanics and materials science etc.

Course Outcomes:

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

1. Apply knowledge of physics to different systems and analyze different problems.
2. Understand the need of quantum mechanics and its importance and applications
3. Get the knowledge to explain electrical conductivity of materials.
4. Get exposed to recent trends in nanoscience and technology.
5. Understand and demonstrate different applications of lasers, optical fibers, superconductors etc.

Course Contents:

UNIT - 1 **[11hrs]**

Wave mechanics: Introduction to Wave mechanics, Wave particle dualism. de-Broglie hypothesis, Matter waves and their characteristic properties. Expression for de-Broglie wavelength of an electron in terms of accelerating potential. Phase velocity and group velocity, Relation between phase velocity and group velocity. Relation between group velocity and particle velocity, Expression for de-Broglie wavelength using the concept of group velocity. Heisenberg's uncertainty principle ,its significance and its applications(non existence of electron inside the nucleus) . Wave function, properties of wave function and physical significance. Probability density and Normalization of wave function, Schrodinger time- dependent and independent wave equation, Eigen values and Eigen functions. Applications of Schrödinger wave equation – energy Eigen values of a free particle, Particle in one dimensional infinite potential well. Numerical.

UNIT - 2: **[10hrs]**

Lasers and optical fibers: Lasers Interaction between radiation and matter (induced absorption, spontaneous and stimulated emission). Expression for energy density at thermal equilibrium in terms of Einstein's coefficients. Characteristics of laser light, Conditions for laser operation (population inversion and Meta stable state). Requisites of laser system, Construction and working of Carbon Dioxide (CO_2) laser &semiconductor laser. Applications: Holography (recording and reconstruction of images) and its applications, Numerical.

Optical fibers: Construction and light propagation mechanism in optical fibers (total internal reflection and its importance), Acceptance angle, Numerical Aperture (NA), Expression for numerical aperture in terms of core and cladding refractive indices, Condition for wave propagation in optical fiber, V-number and Modes of propagation, Types of optical fibers, Attenuation and reasons for attenuation, Applications: Explanation of optical fiber communication using block diagram, Optical source (LED) and detector (Photodiode). Advantages and limitations of optical communications, Numerical.

UNIT - 3: **[11hrs]**

Electrical properties of conductors and superconductors: Electrical Conductivity in Metals, Drude Lorentz classical free electron theory, drift velocity, mean free path, mean collision time and relaxation time. Expression for electrical conductivity in metals, Effect of impurity and temperature on electrical resistivity in metals, Failures of classical free electron theory. Quantum free electron theory, Fermi-Dirac statistics, Fermi level, Fermi energy and Fermi factor, Variation of Fermi factor with energy and temperature, Density of states (qualitative explanation), effective mass, Merits of Quantum free electron theory, Numericals.

Superconductors: Temperature dependence of resistivity in superconductors, variation of critical field with temperature,Properties of superconductors (Isotope effect, Meissner effect, Silsbee effect), Types of superconductors, BCS theory, Applications of super conductors, Maglev vehicle and superconducting magnet.

UNIT - 4: **[10 hrs]**

Ultrasonics, Dielectric and Nanomaterials: **Ultrasonics:** Production of ultrasonics by piezoelectric method, Measurement of velocity of ultrasonics in solid and liquid, Non-destructive testing of materials using ultrasonics.

Dielectric materials: Electric dipole and dipole moment, electric polarization (P), dielectric susceptibility (χ,), dielectric constant, relation between χ and P, Electrical polarization mechanisms (electronic, ionic, orientational, space charge polarization), Expression for internal field in one-dimensional solid dielectrics, Ferro, Piezo and Pyro electric materials – their properties and applications, Numericals.

Nanomaterials: Introduction to nanoscience, nanomaterials and their applications, Synthesis of nano materials using bottom-up method (arc method), top-down methods (ball milling method), Carbon Nanotubes: properties and applications.

Recommended Learning Resources

Text books:

1. Engineering Physics, R.K Gaur and S.L. Gupta, Dhanpat Rai Publications(P) Ltd, New Delhi.
2. A text book of Engineering Physics, M.N. Avadhanulu and P.G. Kshirsagar, S. Chand and Company, New Delhi.
3. Solid State Physics, S.O. Pillai, New Age International publishers, New Delhi.

Reference Books:

1. Laser Fundamentals, William T. Silfvast, 2nd Edition, Cambridge University press, New York(2004).
2. Fundamentals of Physics, 6th Edition, D. Halliday, R. Resnick and J. Walker, John Wiley and Sons, New York (2001).
3. Introduction to Solid State Physics,7th Edition Charls Kittel, Wiley, Delhi (2007).
4. Arthur Beiser, Concepts of modern Physics, Tata McGraw Hill publications, New Delhi.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTCV16F2300	**Elements of Civil Engineering**	16	HC	2	1	0	3	4

Prerequisites: Basic Physics	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

The objectives of this course are to:

1. To enable students to establish a broad concept of engineering mechanics.
2. To enable students to understand the basics of composition of coplanar forces.
3. To enable students to understand the concept of equilibrium of coplanar forces.
4. To provide an overview of centroid of plane area & Moment of Inertia of plane area.

Course Outcomes:

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

1. Describe the moment of force and couples and equivalent force-couple system.
2. Solve numerical problems on composition of coplanar concurrent and non-concurrent force system and solve numerical problems on equilibrium of coplanar force system.
3. Locate the centroid and moment of inertia of different geometry.

Course Contents:

UNIT - 1: [11hrs]

Introduction to Basic Civil Engineering: Scope of civil engineering, role of civil engineer, branches of civil engineering (brief discussion 2 to 3 hours only).

Engineering mechanics: Basic idealizations - Particle, Continuum and Rigid body; Force and its characteristics, types of forces, Classification of force systems; Principle of physical independence of forces, Principle of superposition of forces, Principle of transmissibility of forces; Newton's laws of motion, Introduction to SI UNIT - s, Moment of a force, couple, moment of a couple, characteristics of couple, Equivalent force - couple system, Resolution of forces, composition of forces; Numerical problems on moment of forces and couples and equivalent force - couple system.

UNIT - 2 [10hrs]

Analysis of Force Systems: Composition of forces - Definition of Resultant, Composition of coplanar -concurrent force system, Parallelogram Law of forces, Principle of resolved parts, Numerical problemson composition of coplanar concurrent force systems, Composition of coplanar - non-concurrent force system, Varignon's principle of moments; Numerical problems on composition of coplanar concurrent force systems.

UNIT - 3 [11hrs]

Equilibrium of coplanar forces: Definition of static equilibrium and Equilibrant, Conditions of static equilibrium for different coplanar force systems, Lami's theorem, Concept of Free Body Diagram, Numerical problems on equilibrium of coplanar – concurrent and non concurrent force systems.

UNIT - 4 **[10 hrs]**

Centroid and Moment of InertiaCentroid: Introduction to the concept, Centroid of plane figures, Locating the centroid of triangle, semicircle, quadrant of a circle and sector of a circle using method of integration, Centroid of composite sections; Numerical problems.

Moment of Inertia: Introduction to the concept, Rectangular and polar moment of inertia, Radius of gyration, Perpendicular axis theorem and Parallel axis theorem, Moment of Inertia of rectangle, circle, semi-circle, quarter circle and triangle from method of integration, Moment of inertia of composite areas, Numerical problems.

Text Books:

1. M. N. Shesha Prakash and Ganesh B. Mogaveer, "Elements of Civil Engineering and Engineering Mechanics", PHI Learning, 3rd Revised edition
2. A. Nelson, "Engineering Mechanics-Statics and Dynamics", Tata McGrawHill Education Private Ltd, New Delhi, 2009
3. S. S. Bhavikatti, "Elements of Civil Engineering", New Age InternationalPublisher, New Delhi, 3rd edition 2009.

Reference Books:

1. S. Timoshenko, D.H. Young and J.V. Rao, "Engineering Mechanics", TATA McGraw-Hill Book Company, New Delhi
2. Beer FP and Johnston ER, "Mechanics for Engineers- Dynamics andStatics", 3rd SI Metric edition, Tata McGraw Hill. - 2008
3. Shames IH, "Engineering Mechanics–Statics & Dynamics", PHI–2009.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F2400	**Elements of Mechanical Engineering**	16	HC	2	1	0	3	4

Prerequisites: Basic Physics	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

The objectives of this course are to:

1. To develop the basic knowledge of working of various turbines and IC engines
2. To incorporate the concepts of metal joining process, their applications and power transmission modes like belt drives, gears and gear trains
3. To understand various mechanical machines and operations.
4. Introduce about lubrication and its importance.
5. To understand basic power transmission concepts.

Course Outcomes:

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

1. Apply the concepts of working principle of turbines in the power plants and also of the IC engines in the basic design of the vehicles
2. Have a basic knowledge of metal joining and power transmission and apply them in some basic requirements
3. Gain the knowledge about machine tools, cutting operations ,belt and gear drive power transmission.

Course Contents:

UNIT - 1 **[11 hrs]**

Properties of steam: Introduction**,** Steam formation, Types of steam. Steam properties, Specific Volume, Enthalpy and Internal energy, Steam table and simple numerical problems

Steam Generators – classification, Lancashire boiler, Babcock and Wilcox boiler, Boiler mountings, accessories and applications

Turbines- Introduction to turbines & prime movers, Classification of turbines, Working principle and applications of impulse and reaction steam turbines, gas turbines (open and closed cycle type) and water turbines (Pelton wheel, Francis and Kaplan), Compounding of impulse turbine.

UNIT - 2 **[10 hrs]**

Internal Combustion Engines : Introduction, Classification of IC engines, parts of IC engine, Working principle of four stroke (petrol and diesel) and two stroke petrol engines, differences between 4 Stroke & 2 Stroke engines and petrol & diesel engines, Numerical problems on power and efficiencies.

Refrigeration and Air conditioning- Introduction, Principle of refrigeration, parts of refrigerator, Principle and working of vapor compression refrigeration and vapor absorption refrigeration.

Refrigerants, Properties of refrigerants, Refrigerating effect, Ton of Refrigeration, COP, Relative COP, UNIT - of Refrigeration, Principle and applications of Room air conditioners.

UNIT - 3 **[11 hrs]**

Machine Tools: Introduction, working principle and classification of lathe, drilling and milling machines, major parts of a lathe and their functions, lathe operations on lathe - Specifications of lathe, parts of radial drilling machines, drilling operations, parts of horizontal milling machines, milling operations.

Metal joining processes- Introduction, classification of metal joining processes, method of welding (Electric Arc welding), soldering and brazing and their differences.

UNIT - 4: **[10 hrs]**

Lubrication: Necessity, types of lubrications, properties of good lubricant.

Bearings- Classification and application of bearings only

Power Transmission- Introduction to transmission systems and its classification, types of Belt Drives**,** Definitions of Velocity ratio, angle of contact Creep and slip, Idler pulley, stepped pulley, fast & loose pulley, simple problems.

Gears - Definitions, Spur gear terminology, Types and applications of Gears.
Gear Trains – Simple and compound gear trains, Simple problems on gear trains

Recommended Learning Resources

Text Books:

1. A Text Book of Elements of Mechanical Engineering – K.R. Gopalkrishna, Subhash Publishers, Bangalore.
2. Elements of Mechanical Engineering – Kestoor Praveen and M.R. Ramesh 2nd Edition 2011, Suggi Publications

Reference Books:

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

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTEE16F2500	**Basic Electrical Engineering**	16	HC	2	1	0	3	4
Prerequisites: Basic Physics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

The objectives of this course are to:

1. Concept of various types of generation of electricity.
2. To make students understand the basics of representation of electrical quantities and relationship among them.
3. To provide an overview of various types of electrical apparatus.
4. To introduce the concept of domestic wiring and importance of safety and sensing devices.
5. To provide an insight into various sources of power generation.

Course Outcomes:

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

1. Describe the operation and control of various types of generation of electricity
2. Describe the principle of operation of electrical apparatus
3. Differentiate between single and three phase systems,
4. Solve simple mathematical relationships related to electrical apparatus.
5. Relate the applications of electronic devices and sensors in practical life.

Course Contents:

UNIT - 1 **[11hrs]**

Introduction to Electrical Parameters: Concept of Alternating Voltage and Current, Sinusoidal functions-specifications, Phasor representation, concept of impedance, admittance, conductance and susceptance –series and parallel circuits of RLC. Concept of power and power factor. Kirchoff's laws and network solutions. Electromagnetic induction-laws, direction & magnitude of indusedemf, mmf, permeability, reluctance and comparison of electric and magnetic circuits. Self and mutual inductance of a coil, coupling coefficients. Concept of energy storage in L & C, resonance between L &C. Generation of three phase voltages, star-Wye configurations, relation between line and phase quantities and expression for power.

UNIT - 2 **[10hrs]**

Electrical Apparatus: DC generator, DC motor- concept of force, torque and mechanical work. Single and three phase induction motors, shaded pole motor, universal motor, stepper motor: Basic construction, principle of operation and applications. Single and three-phase transformers: Principle, emf equation.

UNIT - 3 **[11hrs]**

Generation & Distribution: Block diagram representation of generation, transmission and distribution. Current generation and transmission scenario, need for transmission at high voltage. Block diagram representation of thermal, hydel, nuclear, diesel and renewable power plants. Concept of smart-grid and role of ICT in smart-grid.

UNIT - 4 **[10hrs]**

Tariff, Protective Devices and Sensors: Tariff schemes, basic concepts of domestic wiring and types, earthing, protective fuses, MCB. Sensors: pressure sensor, strain gage, proximity sensor, displacement sensor, rotary encoder and ultrasonic sensors (applications in relevant disciplines- ref to 8 and 9)

Recommended Learning Resources

1. Theodore Wildi,"Electrical Machines, Drives, and Power, 5th Systems",Pearson Edition, 2007
2. Hughes, "Electrical Technology", International Students 9th Edition, Pearson, 2005
3. Kulshreshtha C,"Basic Electrical Engineering"Tata McGraw Hill, 2nd Edition, 2011
4. Mittle V.N. and A. Mittal, "Basic Electrical Engineering" Tata McGraw Hill, 2nd Edition, 2005
5. Kothari D.P., L.J. Nagrath"Basic Electrical Engineering",Tata McGraw Hill, 2009
6. Robert L. Boylestad and Louis Nashelsky, "Introduction to Electricicty, Electronics and Electromagnetics" Prentice Hall, 5th edition, 2001
7. Introduction to smart grid: http://www.occ.ohio.gov/publications/electric/Smart_Grid_An_Introduction.pdf
8. Role of ICT in smart grid: http://users.atlantis.ugent.be/cdvelder/papers/2010/develder2010sgc.pdf
9. Sensors: http://www.omron-ap.co.in/technical_guide/
10. Strain gage with bridge circuit: http://www.facstaff.bucknell.edu/mastascu/elessonshtml/Sensors/StrainGage.htm#SensorsInVoltageDividerCircuits

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTIC16F2600	**Indian Constitution and Professional Ethics**	16	FC	1	1	0	2	3

Prerequisites: pre-university level	Internal Assessment	Semester End Exam
Constitution of India and Professional Ethics	40 Marks	60 Marks

Course Objectives:

The objectives of this course are to:

1. provide and gain knowledge on Constitution of India
2. Know and understand about the Fundamental Rights, Duties and other Rights which is been given by our law.
4. Prepare students in the praticality of Constitution perspective and make them face the world as a bonafide citizen.
5. Attain knowledge about ethics and also know about professional ethics.
6. Explore ethical standards followed by different companies.

Course Outcomes:

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

1. Strengthen the knowledge on Indian constitutional law and make the pratical implementation of it.
2. Understand the fundamental rights and human rights.
3. Get the knowledge to explain the duties and more importantly practise it in a right way.
4. Adopt the habit of raising their voice against a non constitutionality of any laws and upon any legal discrimination as we have session of debates on Constitutional validity.
5. Get exposed about professional ethics and know about etiquettes about it.
7. Know about ethical standards of different companies which will increase their professional ability.

Course Contents:

UNIT - 1 Constitution of India [8 hrs]

Definition, Making of Indian Constitution, Preamble to the Constitution of India, Fundamental Rights under Part III; Rights to Equality, Right to Freedom, Right against Exploitation, Rights to Freedom of Religion, Cultural and Educational Rights, Constitutional Remedies. Fundamental Duties of the Citizen, Significance and Characteristics. Elements of National Significance; National Flag, National Anthem, National Emblem.

UNIT- 2 Union and State: [7hrs]

Organs of the Government; Legislature, Executive and Judiciary. Union and State Executives: President, Vice President, Prime Minister, Supreme Court, Cabinet, Governor, Council of Ministers, Electoral process, Election Commission. Right to Information (RTI), Consumer and Consumer Protection.

UNIT - 3 Ethics: [7hrs]

Meaning, Definition, Evolution, Need of ethics, Aristotlean Ethics, Utilitarianism, Katianism, Professional Ethics, Personal Ethics and Business Ethics, Ethical Standards, Duties of Employers and Employees.

UNIT - 4 Engineering Ethics : [6hrs]

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

Recommended Learning Resources

1. M V Pylee, An introduction to Constitution of India

2. M Govindarajan, S Natarajan, V S Senthil Kumar, Engineering

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTTE17F2700	**Technical English-II**	16	FC	0	0	2	2	4

Prerequisites: Basic English	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Outline:

This is a four-credit course for two semesters consisting of 4 hours of teaching learning per week, inclusive of direct classroom teaching and practice in language lab.

Course Objectives:

1. To enable learners of Engineering and Technology develop their basic communication skills in English.
2. To emphasize specially the development of speaking skills amongst learners of Engineering and Technology.
3. To ensure that learners use the electronic media such as internet and supplement the learning materials used in the classroom.
4. To inculcate the habit of reading and writing leading to effective and efficient communication.

Course Outcomes:

On completion of the course, learners will be able to:

1. Listen/view and comprehend different spoken discourses/excerpts in different accents.
2. Speak clearly, confidently, comprehensibly, and communicate with one or many listeners using appropriate communicative strategies.
3. Read different genres of texts adopting various reading strategies.
4. Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.

Course Contents:

UNIT - 1 **[16 Hrs]**

Language in Use: Vocabulary Building, Functional Words, Idioms & Phrasal Verbs, Homonyms & Homophones.

UNIT - 2 **[16 Hrs]**

Employability Skills: Job Applications. Curriculum Vitae, Group Discussions, Presentation Skills Role Plays, Interview Skills, Debates

UNIT - 3 **[16 Hrs]**

Academic Writing – II: Essays, Letters, Dialogues, Proposals.

UNIT - 4 **[16 Hrs]**

Technical Speaking & Reading Skills: Precis (Scientific Passages), Public Speeches, Reading Manuals, Reading Scientific Reports, Interpreting Visual Materials.

Recommended Learning Resources

Text Books:

1. Murphy,Raymond.(1998), Intermediate English Grammar, New York
2. Wren &Martin (2001),English Grammar & Composition, New York
3. Mudambadithaya G.S.,(2002) English Grammar and composition
4. Digne, Flinders and Sweeney(2010) Cambridge University press
5. Lupton, Mary Jane (1998). *Maya Angelou: A Critical Companion*. Westport, Connecticut: Greenwood Press. ISBN 978-0-313-303225.
6. Booher, Diana. (2004), *Booher's Rules of Business Grammar*, OUPUr, Penny .(2002),*Grammar Practice Activities*, OUP
7. Wren &Martin (2001),*English Grammar & Composition*, New York
8. Joan Van Emden and Lucinda Becker Palgrave. Effective Communication for Arts and Humanities Students. Macmillan.
9. Glendinning, Eric H. and Beverly Holmstrom (2008), Study Reading: A Course in Reading Skills for Academic Purposes, New Delhi: CUP.Langan, John (1996). College Writing Skills. McGraw Hills

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTPL16F2800	**Engineering Physics Lab**	16	FC	0	0	2	2	3
Prerequisites: Physics		Internal Assessment			Semester End Exam			
		20 Marks			30 Marks			

Course Objectives:

The objectives of this course are to:

1. Make the students gain practical knowledge of Physics to co-relate with the theoretical studies.
2. Provide students with a theoretical and practical knowledge of Physics.
3. Achieve perfectness in experimental Skills and the study of practical applications improve confidence and ability to develop and fabricate engineering and technical equipments.
4. Provide the idea of basic electronic circuits, optical instruments and will be able to carry out experiments in optics and verify other important laws of Physics.

Course Outcomes:

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

1. Develop skills to apply practical knowledge of Physics in real time solution.
2. To understand and verify different laws of Physics using some simple experiments.
3. To design simple electrical circuits and analyze obtained result.
4. Ability to apply knowledge of basic electronics in making simple circuits using diodes and transistors and analyze the responses.
5. Ability to use the knowledge acquired for different applications and projects.

Course Contents:

List of Experiments:

1. Determination of wavelength of the given laser using diffraction grating.
2. I-V characteristics of Zener-diode – (determination of knee voltage breakdown voltage and forward resistance).
3. Determination of Planck’s constant using LED.
4. Determination of energy gap of a semiconductor.
5. Measurement of dielectric constant by charging and discharging method.

6. I-V characteristics of NPN-Transistor in C-E mode. (Determination of knee voltage input resistance, output resistance, current gain and current amplification factor breakdown).
7. Photo diode characteristics (I-V characteristics in reverse bias, variation of photocurrent as a function of intensity and reverse voltage).
8. Determination of Young's modulus of the material by single cantilever method/uniform bending method.
9. Determination of resonant frequency, band width and quality factor of the given LCR series and parallel resonance circuits.
10. Determination of rigidity modulus of the material and moment of inertia of an irregular body using Torsional pendulum.
11. Measurement of numerical aperture and attenuation in optical fibers. (Demo Expt.)
12. Determination of electrical resistivity by four probe method. (Demo expt.)
13. Measurement of velocity of ultrasonics in the given liquid-acoustic grating method. (Demo Expt.)

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTEW16F2900	**Workshop Practice**	16	HC	0	0	2	2	3
Prerequisites: Mechanical Engineering Science		Internal Assessment				Semester End Exam		
		20 Marks				30 Marks		

Course Objectives:

The objectives of this course are to:

1. To train students in metal joining process like welding, soldering etc.
2. To impart skill in fabricating simple components using sheet metal.
3. To cultivate safety aspects in handling of tools and equipment.

Course Outcomes:

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

1. Welding and soldering operations.
2. Fabrication of simple sheet metal components
3. Make fitting models as per the standards.

Course Contents:

Part-A Fitting

1. Introduction to Fitting tools.
2. Making fitting models (5 Models) by use of filing, cutting, drilling and finishing operations.

Part-B Welding, Sheet Metal work and Soldering

1. Instruction of standards and reading of welding drawings.
2. Making Butt joint, Lap joint, Corner joint.
3 Making of Cube, Prism, Cone, Cylinder, and Funnel using development of lateral surfaces.
4. Soldering of sheet metal models.

Text Books:

Workshop Manual Prepared by REVA University Staff

THIRD SEMESTER

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3100	**Engineering Mathematics – III**	16	HC	3	0	1	4	4
Prerequisites: Engineering Mathematics I & II		Internal Assessment 40 Marks			Semester End Exam 60 Marks			

Course Objectives:

1. Learn to solve algebraic, transcendental equations and finite difference, interpolation and its application.
2. Learn to solve ordinary differential equations numerically using different methods.
3. Learn the concept of Random variables and probability distributions.
4. Construct the various tests essentially needed for the testing of small samples for the testing of hypothesis

Course Outcomes:

After the completion of the course the student will be able

1. To understand the basics of numerical methods and their applications.
2. Solve the problems of algebraic, transcendental equation and use a given data for equal and unequal intervals to find a polynomial function for estimation.
3. Apply Interpolation technique to approximate the value of the integral for the functions.
4. To solve the problems of ordinary differential equations using various methods.
5. Apply the concepts of probability distribution to solve the engineering problems.

6. Use the concepts of sampling to enable a student to take a decision about the hypothesis.

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Course Contents:

UNIT-I **[13 hrs]**

Numerical Methods –I: Introduction, solution of algebraic and Transcendental equation , Bisection method , Regular false method , Newton Raphson method .

Finite differences and Interpolation :-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 and Problems.

UNIT -2 **[13hrs]**

Numerical Methods –II: Numerical Differentiation and Integration:- Derivatives using Newton's forward and backward difference formula.

Numerical Integration: Trapezoidal Rule, Simpson's $1/3^{rd}$, $3/8^{th}$ Rule, Weddle's formula and Problems.

Numerical solutions to ODE: First order and first degree, Picards Method , Taylor's series method , Modified Euler's method , Runge-Kutta method of fourth order, Adam's-Bashforth Predictor-corrector method and Problems.

UNIT-3 **[13hrs]**

Introduction of Probability, Probability associated with set theory, addition law, conditional Probability, multiplication law, Baye's Theorem.

Random variables (discrete and continuous), Probability density function, probability distribution – binomial and Poisson's distributions; exponential and normal distributions.

UNIT- 4 **[13hrs]**

Sampling theory:-Sampling, Sampling distributions, standard error, test of hypothesis for means and confidence limits , Student's t-distribution and Chi-square distributions.

Joint Probability distribution:-Concept of joint probability, joint distributions –discrete random variables, independent random variables, problems on expectation and variance.

Recommended Learning Resources

Text books:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43^{nd} edition, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 10^{th} edition, 2015.

Reference Books:

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19^{th} edition, 2013.
2. R.K. Jain and S.R.K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 5^{th} edition, 2014.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3200A	**MATERIAL SCIENCE AND METALLURGY**	16	HC	3	0	0	3	3
Prerequisites: Engineering Physics and Chemistry		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. The main objective of this course is to provide the basic knowledge required to explore the discipline of materials science and engineering.
2. To develop the knowledge of the structure of materials which includes crystallography, microstructure, defects, and phase diagrams
3. To give an idea about the heat treatment required for the metals
4. To incorporate the knowledge in various class of materials and their applications

Course Outcomes:

After completion of the course the Student will be able to

1. Understand how materials are classified based on atomic arrangement and behavior of materials in elastic and plastic regions
2. Identify the type of failures and also to perform fatigue test
3. Identify the different phases of iron and apply required heat treatment process for the industrial purposes
4. Gain knowledge on different class of materials and their applications

Course Contents:

UNIT-1: Mechanical Behavior of Materials [12 hrs]

Stress – strain diagram for ductile and brittle materials, elastic and plastic deformation, mechanical properties in elastic and plastic region, linear and non-linear properties (no numerical)
Creep – Phenomenon, stages of creep and creep properties. Fatigue- Types of fatigue loads, fatigue properties, Fatigue test and S- N curves.
Fracture: Mechanism of fracture, ductile and brittle fracture, Griffith's theory of fracture (only derivation), ductile to brittle transition

UNIT–2: Solidification and Phase diagrams [12 hrs]
Mechanism of solidification, homogeneous and heterogeneous solidification, Hume Rothary rules substitution and interstitial solid solutions. Construction of phase diagram for two component systems, application of Gibbs phase rule. Construction of phase equilibrium diagram involving complete and partial solid solubility, application of lever rule. (with numerical), Iron carbon equilibrium diagram and invariant reactions.

UNIT-3: Heat treatment of metals & Alloys [12 hrs]

Heat treatment of metals: Annealing method and its types. Normalizing, hardening, tempering, martempering, austempering. Hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys. (Methods with applications)

UNIT-4: Smart and Composite Materials **[12 hrs]**

Materials exhibiting ferroelectric, piezoelectric, optoelectric, semiconducting, photo conductivity, super conductivity behavior (Examples with applications). Nanomaterials, properties and applications. Introduction to bio materials, superalloys and shape memory alloys.

Composite materials – Introduction classification, difference between conventional Production of FRP's – hand layup and spray up process, Production of MMC's – Stir casting process and spray forming process and composite materials, advantages, limitations and applications.

Text Books:

1. Foundations of Materials Science and Engineering, Smith, 4th Edition McGraw Hill, 2009
2. Materials Science, Shackleford., & M. K. Muralidhara, Pearson Publication – 2007.
3. Foundations of Materials Science and Engineering , William Smith , McGraw-Hill Science Engineering Math.
4. Material science, shackleford.,& M. K Muralidhara, Pearson Publications - 2007

Reference Books:

1. An Introduction to Metallurgy; Alan Cottrell, Universities Press India Oriental Longman Pvt. Ltd., 1974.
2. Engineering Materials Science, W.C.Richards, PHI, 1965
3. Materials Science and Engineering, V.Raghavan , PHI, 2002
4. Materials Science and Engineering,William D. Callister Jr., John Wiley & Sons. Inc, 5th Edition, 2001.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3200B	**MECHANICAL MEASUREMENTS AND METROLOGY**	16	HC	3	0	0	3	4
Prerequisites: Basic knowledge on physics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Impart the knowledge of standards importance and conversion.
2. Define the fundamental concepts and derive the relations for the design of gauges, types of gauges, concepts involving comparators, angular measurements, screw thread and gear measurements.
3. Define the fundamental methods of measurement, concept of transducer and intermediate modifying devices and terminating devices.
4. Clear exposure to the errors, classification and remedies.

5. To explore the students to various aspects regarding the force, torque, strain, pressure and temperature measurements.
6. To identify, analyze the concept and the principle advantages and applications of the above measurements.

Course Outcomes:

1. Students learn and understand the need, history for the development of new concepts with metrology and measurement.
2. Students will demonstrate the knowledge of standards, comparison between the standards and their conclusion.
3. Will have learnt the capability to recognize the need for measurement, the fundamental concepts of measurement, conduct the experiments and record the data and interprete the results.
4. Will have acquired the ability to recognize the concept of errors and accuracy.
5. Will have the capability to apply the skills in measuring force, torque, strain, pressure and temperature.
6. Will have acquired the ability to recognize the global, societal and ethical aspects of the work with social and ethical responsibilities as related to metrology and measurement.

Course Contents:

UNIT-1: Standards of Measurement: [12 hrs]

Introduction, Definition and Objectives of metrology, Role of standards, Standards of length-International prototype meter, Imperial standard yard, Light wave length standard, subdivision of standards, line and end standard, comparison, calibration of end bars (Numerical), Slipgauges, Requirements and manufacture of slip gauge, Wringing phenomena, Indian Standards (M-45,M-87, M-112), Numerical problems on building of slip gauges.

Limits, Fits ,Tolerance and Gauging: Introduction, Need of limit systems, Definition of Limit and tolerance, Specification in assembly, interchangeability and selective assembly ,limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919-1963), geometrical tolerance, positional-tolerances, system of fits, Tolerance grade, Numerical problems, classification of gauges, brief concept of design of gauges (Taylor's principles),Types of gauges-plain plug gauge, ring gauge.

UNIT-2: Comparators and Angular measurement: [12 hrs]

Introduction to comparators, Need for a comparator, characteristics, classification of comparators, mechanical comparators- Johnson Mikrokator, sigma comparators, dial indicator, optical comparator: Principle of optical lever, Zeiss ultra optimeter, Advantages and Disadvantages, LVDT, Advantages and Disadvantages, pneumatic comparators:principle, solex comparator, Angular measurements, Vernier bevel protractor use of angle gauges (numericals on building of angles).

Interferometer, screw thread and gear measurement:

Principle of interferometry, Interference pattern, optical flat, autocollimeter, Screw thread: Introduction, Terminology, types and errors. Measurement of major diameter, minor diameter, effective diameter of screw threads by 2-wire and 3-wire methods, Expression for best size wire. Tool

maker's microscope, gear tooth terminology, use of gear tooth vernier caliper for thickness and depth measurement.

UNIT-3: Measurements and measurement systems: [12 hrs]

Introduction, Definition, Requirement of measurements, significance of measurement system, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysterisis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers. Mechanical members: Bourdon tube, Diaphragm, Bellows. Electrical members: Resistive, capacitive, piezoelectric and photoelectric transducers.

Intermediate modifying and terminating devices: Introduction, Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers, Vacuum tube amplifiers and telemetry. Introduction to Terminating devices, Meter indicators, CRO, Measurement of frequency, oscillographs, X-Y plotters.

UNIT-4: Measurement of force, torque and pressure: [12 hrs]

Introduction, Direct method: Analytical balance, unequal arm balance, Platform balance, proving ring. Torque measurement: Mechanical, hydraulic dynamometer, Pressure measurements, principle, Bridgeman gauge, McLeod gauge, Pirani gauge .

Temperature and strain measurement: Introduction, Resistance thermometers, thermocouple, law of thermo couple, Thermocouple materials and construction, Measurement of thermal emf, pyrometer, optical pyrometer, Radiation pyrometers. Strain measurements, strain gauge, preparation and mounting of strain gauges, methods of strain measurement.

Text Books:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. Engineering Metrology, R.K. Jain, Khanna Publishers, 1994.

Reference Books:

1. Engineering Metrology, I.C. Gupta, Dhanpat Rai Publications, Delhi.
2. Mechanical Measurements, R.K. Jain Khanna Publishers, 1994.
3. Industrial Instrumentation, Alsutko, Jerry. D. Faulk, Cengage Asia Pvt. Ltd. 2002.
4. Measurement Systems Applications and Design, Ernest O. Doebelin, 5th Ed., McGraw Hill Book Co.
5. Metrology & Measurement, Anand K. Bewoor & Vinay A. Kulkarni, Tata McGraw.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3300	**STRENGTH OF MATERIALS**	16	HC	3	1	0	4	5
Prerequisites: Engineering Mechanics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

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Course Objectives:

1. To Gain knowledge of simple stresses, strains and deformations components due to external loads and study on the behavior of ductile and brittle materials.
2. To assess stresses and deformations of beams, twisting bars or combination of both.
3. To Provide the basic knowledge of columns and practical applications
4. To Provide the Basic knowledge for use in the design courses.

Course Outcomes:

After completion of the course the student will be able to

1. Understand the basic principles of structural elasticity, including statically determinate and indeterminate systems, and the factors which affect their strength and stiffness.
2. Assess the strength and stiffness of simple structural components.
3. Apply the effect of stress and deformation concepts in practical applications.
4. Apply knowledge on shafts subjecte to twisting and bending which helps in design of shafts

Course Contents:

UNIT-1

Simple Stresses & Strains: **[12 hrs]**

General meaning of stress, types of simple stresses and strains. Stress- strain diagrams for ductile and brittle materials, Saint Venant's principle, Hooke's law, Extension/shortening of bar, Bars with varying cross section and loads, Bars of tapering section, Principles of super positions, Elongation due to self weight, statically indeterminate systems, compound bars, Numerical

Elastic Constants: Lateral strain, Poisson's ratio, volumetric strain, Rectangular block subjected to normal stresses on all three of its faces; Bulk modulus, relation between Young's modulus and Bulk modulus. Shear modulus, Relation between Young's modulus and rigidity modulus. Study on temperature stresses, Temperature stresses in compound bars. Numerical

UNIT-2 **[12 hrs]**

Compound stresses and strains:

Stresses in two dimensional system, plane Stress transformation, Elements subjected to two dimensional stress system, Principal planes, principal stress and principal strain, Maximum shear stress and shear plane, principal strain, Mohr's circle for plane stress and strain.

Torsion of Shafts:

Introduction, Torsional equations of Solid and Hollow Circular Shafts, Torsional Rigidity/Stiffness, Power Transmitted by the Shaft, Importance of Angle of Twist and Shear Stresses in Shafts, comparison of Solid and Hollow Shafts, Numerical

UNIT-3 **[12 hrs]**

Shear Force and Bending Moment Diagram: Introduction, types of beams and loads, definition of shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to concentrated loads (point load), uniform distributed load (UDL) uniformly varying load (UVL) and couple for simply supported, cantilever & overhanging beams. Numerical.

Bending stress : Theory of Simple Bending (Bending equation/ Flexural Formula), Assumptions, Position of Neutral Axis, Section Modulus, Practical Applicationsof Bending Equation, Numerical (symmetrical section only).

UNIT-4: **[12 hrs]**

Deflections of Beams: Beam Deflection, Relation between Slope, Deflection and Radius of Curvature, Slope and Deflection at a Section, Double Integration Method, simply supported, cantilever beams. Numerical

Columns & Struts: Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Euler's formulae for the elastic buckling load, Eulers, Rankine formula for axial loading columns and their applications, Numerical.

Text Books:

1. "Mechanics of materials", Beer & Russell Johnstan, in S.I. Units, Ferdinand TATA Mc GrawHill- 2003.
2. "Strength of Materials", S.S.Bhavikatti, Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
3. "Engineering Mechanics and Strength of Materials", by R K Bansal, Laxmi Publications-New Delhi (2004)

Reference Books:

1. "Mechanics of Materials", by R.C.Hibbeler, Printice Hall. Pearson Edu., 2005
2. "Strength Of Materials",by S Ramamrutham, R Narayana, Dhanphatrai publishing Co.Ltd.2003
3. "Strength Of Materials", by Timoshenko.S.P Part1,D.Van Nostrand company, Inc.Newyork

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3400	**BASIC THERMODYNAMICS**	16	HC	3	1	0	4	5
Prerequisites: PU Physics & Chemistry		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

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Course Objectives:

1. To learn the fundamentals of thermodynamics and related concepts to understand the basic units and its measurement and thermodynamic principle.
2. To understand the concept of thermodynamic work, heat and the fundamental laws of thermodynamics.
3. To learn the basics of heat engine, heat pump, refrigerator and Carnot principle and their practical applications.
4. To understand the concept of entropy and behavior of pure substances and its importance in practical applications.
5. To study the behavior of Ideal gases and Real gases.

Course Outcomes:

1. Students can able to analyze the principles of thermodynamics in engineering applications.
2. Able to calculate work, heat and other parameters involved in thermodynamic system during execution of process and cycle.
3. Analysis of various systems under different circumstances in thermodynamic point of view.
4. Able to find performance of engineering devices like heat engine, heat pump and refrigerator.
5. Behavior of working fluid in various thermodynamic systems.
6. R and D work involving automobile, energy and aeronautical applications.
7. This subject is prerequisite for future semester subjects like applied thermodynamics, heat transfer, hence he/she can study those subjects without difficulty.

Course Contents:

UNIT-1 Fundamental Concepts & Definitions [12 hrs]

Thermodynamics; Types thermodynamics System, closed open and isolated systems; examples Microscopic and Macroscopic approaches.. Thermodynamic properties; definition and units, intensive and extensive properties. Thermodynamic state process and cycle, path and point function, quasi-static process, cyclic and non-cyclic processes; Thermodynamic equilibrium; mechanical equilibrium; thermal equilibrium, chemical equilibrium- Equality of temperature Zeroth law of thermodynamics, Temperature; concepts, scales and measurement. Numerical.

Work and Heat: Mechanics Definition of Work and limitations, Thermodynamic definition of work; examples sign convention. Displacement work, expressions for displacement work in various processes through p-v diagrams. Show that work as path function, Electrical work, Paddle wheel work and flow work. Heat: definitions, units, sign convention, specific heats, show that heat is a path function. Comparison between work and heat. Simple numerical.

UNIT-2: [12 hrs] First Law of Thermodynamics

Joule's experiments, First law for a closed system undergoing a cycle; First law for a closed system undergoing a change of state; Energy – A property of a system; Energy balance for closed system, different forms of stored energy; Enthalpy, Specific heat at constant volume, and constant pressure; PMM1; control volume, study flow process; Mass and energy balance for study flow process; some study flow engineering devices; Limitations of first law of thermodynamics Numerical.

Second Law of Thermodynamics

Introduction to second law; Qualitative difference between heat and work; Cyclic heat engine; Thermal energy reservoirs; Kelvin-Plank statement and Clausius statement of second law of thermodynamics; Refrigerator and heat pump, equivalence of both statements; PMM II; Reversibility and irreversibility, causes of irreversibility; Carnot cycle, Reversed heat engine; Carnot's theorem ,corollary of Carnot's theorem; Absolute thermodynamic temperature scale; Numerical.

UNIT-3: [12 hrs]

Entropy

Introduction to entropy; Two reversible adiabatic paths cannot intersect each other; Clausius Theorem; The properties of entropy; Prove entropy as property of system; Inequality of Clausius; Temperature-Entropy diagram, representation of Carnot cycle on T-S diagram; Entropy principle and application of Entropy principle; The T-ds equations; Equations for change in entropy during thermodynamic processes; Numerical.

Ideal Gases & Ideal Gas Mixtures

Ideal gas; Equation of state of gas; Universal and particular gas constants, perfect and semi-perfect gases; Evaluation of heat, work, change in internal energy, enthalpy and entropy in various quasi-static processes; Ideal gas mixture; Dalton's law of partial pressure; Internal energy, enthalpy and specific heats of gas mixtures; Entropy of gas mixture; Numerical.

UNIT-4: **[12 hrs]**

Real Gases

Introduction; Vander Waal's Equation Van-der Waal's constants in terms of critical properties, law of corresponding states, compressibility factor; compressibility chart. Numerical.

Pure substance

P-T and P-V diagrams; triple point and critical points,; sub cooled liquid, saturated liquid, mixture of saturated liquid and vapour; saturated vapour and superheated vapour states of a pure substance with water as example; Enthalpy and entropy of change of phase (Latent heat); dryness fraction, T-S and h-s diagrams, representation of various processes on these diagrams; throttling calorimeter, separating and throttling calorimeter. Numerical.

Text Book:

1. Nag P.K. Basic & Applied Thermodynamics. Tata McGraw Hill Pub. Co. 2002.
2. Rajput R.K, Thermal Engineering. Lakshmi publications.

Reference Book

1. Yunus A. Cenegal and Michael A. Boles, "Thermodynamics -An Engineering Approach", Tata McGraw-Hill.2002.
2. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill, Prentice-hall of India Pvt. Ltd.
3. G J Van Wylen and R E Sonntag, "Fundamental of Classical Thermodynamics", Wiley Eastern.1st edition,2002
4. Guptha and Prakash " Thermodynamics'

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3500	**MANUFACTURING TECHNOLOGY – I**	16	HC	3	0	0	3	3
Prerequisites: Basics in Mechanical Engineering		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To gain theoretical and practical knowledge in material casting processes and develop an understanding of the dependent and independent variables which control materials casting in a production setting.
2. To study how to select appropriate production processes for a specific application.
3. Introduce students to good foundry practices and product design considerations.

4. To know the fundamentals of joining processes and non-destructive testing

Course Outcomes:

After completion of the course the student will be able to

1. Demonstrate understanding of non-chip forming processes such as casting, forging, metal joining, etc.
2. Understand basics of metallurgy of welding.
3. Identify the role of Non Destructive Techniques in production processes.

Course Contents:

UNIT -1: Patterns and Pattern Making [12 hrs]

Introduction to Foundry – Classification of manufacturing process, Steps involved in casting, advantages, limitations and applications of casting process. Pattern types, allowances for pattern, pattern materials, color coding.

Sand Moulding : Base sand, Requirements of base sand, Methods of Moulding, Binder and additives, Methods of preparation of moulding sand, Different types of sand mix for sand moulds, properties of moulding sand, Types of sand moulds, Special moulding methods, Moulding Machines : Jolt type, Squeeze type, Jolt & Squeeze type and Sand slinger

UNIT -2: Core Making [12 hrs]

Cores: Definition of core, Core binder, Requirements of core sand, Types of cores, core making process, classification of cores, Equipment for baking of cores.

Metal moulds: Metallic moulds, Types of metallic mould castings: Gravity mould castings, pressure die castings, Centrifugal castings, Slush castings, Squeeze castings, Thixo casting, Continuous casting. Concept of Gating, risering, Fettling and cleaning of castings, casting defects.

Melting Furnaces: Selection of melting furnace, Classification of melting furnaces, Constructional features & working principle of coke fired, oil fired and Gas fired pit furnace, Resistance furnace, Crucible furnace, Cupola furnace, Induction furnace, Electric arc furnace, calculation of cupola charges-Degasification, inoculation, pouring techniques.

UNIT -3: Welding [12 hrs]

Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Gas welding Principle, Oxy – Acetylene welding, Chemical Reaction in Gas welding, Types of flame and Flame characteristics.

Electric Arc welding: Striking an Arc, Arc welding parameters, Classification of Arc welding, MAW, FSMAW, TIG, MIG, SAW, Arc welding current and voltage, Arc welding equipments, Comparison of AC and DC welding.

Special Welding: Resistance welding - principles, Seam welding, Butt welding, Spot welding and projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding, ultrasonic beam welding.

UNIT -4: Metallurgy of welding [12 hrs]

Metallurgical aspects in welding, Structure of welds, Formation of different zones during welding. Heat affected zone (HAZ). Parameters affecting HAZ, shrinkage and residual stresses in welding,

weld ability, welding of special materials – Stainless steel, Aluminium etc. weld ability of cast iron, steel, stainless steel, aluminium alloys, Welding defects.

Soldering and Brazing: Principles of soldering & brazing: Parameters involved & Mechanism, Different Types of Soldering & Brazing Methods.

Inspection Methods – Methods used for Inspection of casting and welding-Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection.

Text Books:

1. "Manufacturing Process-I", Dr.K.Radhakrishna, Sapna Book House, 5th Revised Edition 2009.
2. "Manufacturing Technology: Foundry Forming and Welding", P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.

Reference Books:

1. Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed. Pearson Edu. 2006.
2. "Manufacturing Technology", Serope Kalpakjian, Steuen. R. Sechmid, Pearson Education Asia, 5th Ed. 2006.
3. Heine, Loper and Rosenthal, "Principles of Metal Casting", Tata Mc Graw Hill Publishing Co, Ltd; New Delhi, 1995.
4. Doehler.E.H, "Die Casting", McGraw Hill Book Co. New York.1991.
5. Banga T.R; and Agrawal R.L, "Foundry Engineering", Khanna Publishers, 1992.
6. Serope Kalpakjian, Steven R.Schmid, "Manufacturing Engineering and Technology". (4th Edition), Prentice Hall 2000-06-15 ISBN:0201361310
7. Gupta R.B, "Foundry Engineering"Satyaprakashan, 1989.
8. Lal, Mand Khanna O.P A, "Text Book of Foundry Technology", Dhanpat Rai and Sons, 1986.
9. Jain P.L, "Principles of Foundry Technology", Tata Mc Graw Hill Publishing Company, Ltd; 1995".

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3600A	**COMPUTER AIDED MACHINE DRAWING**	16	HC	1	0	2	3	5
Prerequisites: Computer Aided Engineering Drawing		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

- Understand drawing and develop capacity to represent any matter/object with the help of picture.
- Develop primary knowledge of working drawing.
- Produce orthographic drawing of different machine parts.
- Develop skill to produce assembly drawings.

Course Outcome:

After completion of the course the student will be able to

1. Capability of understanding the graphical language.
2. Draw detailed schematic and simplified drawings in sections and elevation using ANSI standards.
3. Be able to analyze and design common machine elements.
4. Become more familiar with the range and function of common machine elements. 5. Students should be able to apply this knowledge to generating new, innovative design

Course Content:

UNIT–1: Introduction to Geometrical Tolerance and Dimensioning (GD&T) [12 hrs]
Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings).
Thread Forms: Thread terminology, sectional views of threads: ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.

UNIT-2: [12 hrs]
Fasteners: Orthographic projection of Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly).
Keys & Rivetted Joints : Parallel key, Taper key, Feather key, Gibhead key and Woodruff key. Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets).

UNIT -3: [12 hrs]
Mechanical Joints: Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.
Couplings: Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)

UNIT–4: Assembly Drawing [12 hrs]

Screw jack (Bottle type), Machine vice, Plummer block (Pedestal Bearing), I.C. Engine connecting rod, Tailstock of lathe, Tool Head of a shaper, Rams Bottom Safety Valve, Feed Check Valve.

Text Books:

1. 'Machine Drawing', K.R. Gopala Krishna, Subhash Publication, Bangalore,2013
2. 'Machine Drawing', N.D.Bhat & V.M.Panchal

Reference Books:

1. 'A Text Book of Computer Aided Machine Drawing', S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007.
2. ' CAD for engineers and designers', Sham Tickoo. Dream tech 2005
3. 'Machine Drawing', N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata McGraw Hill,2006

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3600B	**FLUID MECHANICS**	16	HC	2	1	0	3	4
Prerequisites: Basic Physics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To give an introduction and explain basic fundamentals of fluid mechanics. Also to learn fluid properties and pressure measurements
2. To incorporate concepts of stability of floating and submerged bodies which are essential in the field of shipping industries. To gain the knowledge of kinematics and dynamics of the fluids.
3. To know the applications of Bernoulli's equation like flow measuring devices, dimesional analysis and also the flow behavior and losses in the pipes
4. The know the importance of Reynolds number, boundary layer theory and also to give an introduction to compressible and Navier stokes equation

Course Outcomes:

After completion of the course the student will be able to

1. Utilize the properties of fluid and pressure concepts for various practical purposes
2. Find the stability and comfort conditions of the marine vehicles. To use the concepts of Bernoulli equation and continuity equation for the various engineering purposes
3. Find the dependent and independent parameters for a model of fluid flow, analyze the model and the prototype and also design the flow through pipes
4. Distinguish the laminar and turbulent flows, apply the knowledge of lift and drag forces in aerospace industries

Course Contents:

UNIT-1: **[12 hrs]**

Properties of Fluids: Introduction, types of fluid, properties of fluids, viscosity, compressibility, surface tension, capillarity.

Fluid Statistics: Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple and differential manometers. Total pressure and center of pressure on submerged plane(horizontal, vertical and inclined) surfaces.

UNIT -2: **[12 hrs]**

Buoyancy, center of buoyancy, metacentre and metacentric height, equilibrium conditions of floating and submerged bodies, determination of Metacentric height experimentally and theoretically. Kinematics: Types of fluid flow, continuity equation in 2D and 3D (Cartesian Co-ordinates only), velocity and acceleration, velocity potential function and stream function , simple problems.

Fluid Dynamics: Introduction equation of motion, Euler's equation of motion, along stream line and Bernoulli's equation, limitations of Bernoulli's equation, simple problems.

UNIT -3: **[12 hrs]**

Fluid Flow Measurements : Venturi meter, orifice meter, pitot-tube, V-Notch and rectangular notches, Dimensional Analysis : Introduction, Rayleigh's method, Buckingham theorem, dimensionless numbers(only theory).

Flow through pipes : Minor losses through pipes(no derivations). Darey's and Chezy's equation for loss of head due to friction in pipes. HGL and TEL, simple numerical.

UNIT -4: **[12 hrs]**

Laminar flow : Reyonold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. Flow past immersed bodies : Drag, Lift, expression for lift and drag, boundary layer theory, definitions and expressions of displacement, momentum and energy thickness.

Text Books:

- Fluid Mechanics, Dr. Bansal, R.K.Lakshmi Publications, 2004.
- Hydraulics and Fluid Mechanics Including Hydraulics Machines, P.N Modi and S.N Seth,,19 Edition Standard Publishers Distributors (2013)

Reference Books:

1. Fluid Mechanics (SI Units), Yunus A. Cengel John M.Oimbala, 2nd Ed., Tata McGraw Hill, 2006.
2. Fluid Mechanics, Oijush.K.Kundu, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005.
3. Fluid Mechanics and hydraulics, Dr.Jagadishlal: Metropolitan Book Co-Ltd., 1997.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3700A	**MATERIALS SCIENCE LAB**	16	HC	0	0	2	2	3
Prerequisites: Material Science		Internal Assessment			Semester End Exam			
		20 Marks			30 Marks			

Course Objectives:

1. To prepare the specimen for metallographic examination
2. To study the wear characteristics of the given specimen
3. To study the tensile , compressive and shear prosperities of metals and non metals
4. To evaluate Brineel, Vicker's and Rockwell's hardness of the materials
5. To find impact strength of the given material
6. To find the endurance limit of the material

Course Out comes:

After completion of the course the student will be able to

1. Identify the type of material based on the microstructure using optical microscope.

2. Carry out wear test to find wear prosperities.
3. Find out the defects in the given specimen using Ultrasonic flaw detection, Magnetic crack detection and Dye penetration test.
4. Find out tensile, compressive, torsional and bending properties of the given material using UTM.
5. Find hardness of the given material
6. Find impact strength of the given material.

Course Content:

PART – A

1. Preparation of specimen for Metallograpic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.

2. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.

3. Non-destructive test experiments like,
   a. Ultrasonic flaw detection
   b. Magnetic crack detection
   c. Dye penetration testing. To study the defects of Cast and Welded specimens

PART – B

1. Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine
2. Torsion Test
3. Bending Test on metallic and nonmetallic specimens.
4. Izod and Charpy Tests on M.S, C.I Specimen.
5. Brinell, Rockwell and Vickers's Hardness test.
6. Fatigue Test.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3700B	**METROLOGY AND MEASUREMENT LAB**	16	HC	0	0	2	2	3

Prerequisites: Basic Physics	Internal Assessment	Semester End Exam
	20 Marks	30 Marks

Course Objectives:

1. Educate students on different measurement systems and on common types of errors.
2. Introduce different types of sensors, transducers and strain gauges used for measurement.
3. Give knowledge about thermocouples, thermometers and flow meters used for measurements

4. Introduce measuring equipment's used for linear and angular measurements.
5. Familiarize students with surface roughness measurements on machine components

Course Out comes:

After completion of the course the student will be able to

1. Choose the proper measuring instruments for the measurement of pressure, Force, temperature, linear distance, speed, surface finish etc., using calibration technique
2. Measure the depth and thickness of the given gear tooth using gear tooth Vernier caliper.
3. Demonstrate the measurement of cutting forces, thread components, angular components.
4. Recognize screw thread parameters using floating carriage measuring machine
5. Analyze tolerance of drilled components using mechanical comparator Work in Quality control and quality assurances divisions in industries
6. Distinguish the various interference patterns by using optical flat.

Course Content:

PART-A: MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART-B: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set

- Measurement of cutting tool forces using
  a) Lathe tool Dynamometer
  b) Drill tool Dynamometer.
- Measurement of Screw threads Parameters using Two wire or Three-wire method.
- Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
- Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer
- Calibration of Micrometer using slip gauges
- Measurement using Optical Flats

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3800A	**MANUFACTURING TECNOLOGY LAB**	16	HC	0	0	2	2	3
Prerequisites: Concept on forging and foundry		Internal Assessment			Semester End Exam			

	40 Marks	60 Marks

Course Objectives:

1. The course will introduce desirable properties of molding sand and establish its relevance in preparing the sand mold.
2. To introduce the experimental procedure in determining the GFN, Permeability, Strength of mold, moisture & clay content in sand sample, core hardness & mold hardness.
3. To bring in the effect of clay & water content on the various properties of molding sand.
4. To give students hands on practice in preparing the sand moulds (Cope & Drag box) using single piece, split pattern and without using pattern.
5. To give students hands on practice in preparing forging models using open -hearth furnace by performing upsetting, drawing & bending operation.

Course Out comes:

After completion of the course the student will be able to

1. Describe general properties of molding sand.
2. Illustrate the influence of Grain fineness of the silica sand used in the preparation of the mold
3. Determine the compression, shear, tensile strength & permeability of a molding sand for different proportion of clay.
4. Determine the percentage of clay & moisture content for a given sand sample
5. Identify the different tools used in foundry & Forging practice with their uses
6. List the different stages involved in preparing the sand mold box & forged model
7. Create the sand mold cavity using cope & drag box with pattern or without pattern
8. Demonstrate the upsetting, drawing & bending operation in preparing the forged model

Course Content:

PART – A

1. Testing of Moulding sand and Core sand:

Preparation of sand specimens and conduction of the following tests:

a) Compression, Shear and Tensile tests on Universal Sand Testing Machine.
b) Permeability test
c) Core hardness & Mould hardness tests.
d) Sieve Analysis to find Grain Fineness number of Base Sand
e) Clay content determination in Base Sand

PART – B

2. Foundry Practice

a) Use of foundry tools and other equipments.
b) Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).
c) Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART – C

3. Forging Operations:

a) Calculation of length of the raw material required to do the model.

b) Preparing minimum three forged models involving upsetting, drawing and bending operations.

c) Out of these three models, at least one model is to be prepared by using Power Hammer.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F3800B	**MACHINE SHOP**	16	HC	0	0	2	2	3
Prerequisites: Manufacturing Technology		Internal Assessment 20 Marks			Semester End Exam 30 Marks			

Course Objectives:

1. To understand various operations carry out through various machines.
2. To provide knowledge about various machine tools.
3. To learn turning, milling and shaping operations.
4. To prepare the model as per the given dimensions

Course Out comes:

After completion of the course the student will be able to

1. Identify the various operations require to prepare the model.
2. Select the suitable machine for a particular operation.
3. Prepare the specimen as per the given dimension for the given raw material.
4. Work in a manufacturing industry.

Course Contents:

Part-A

Preparation of various models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART-B

Cutting of V Groove/ dovetail/Rectangular groove using a shaper.

Cutting of Gear Teeth Using Milling Machine

FOURTH SEMESTER

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4100	**ENGINEERING MATHEMATICS-IV**	16	HC	4	0	0	4	4
Prerequisites: Engineering Maths I, II & III		Internal Assessment		Semester End Exam				
		40 Marks		60 Marks				

Course Objectives:

1. Formulate, solve and analyze engineering problems.
2. Apply numerical methods to solve differential equations.
3. Understand the fundamental concepts of Complex Analysis such as analytic functions, complex integrals and a range of skills which will allow students to work effectively with the concepts.
4. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
5. To find the extrema of some quantity over a system that has functional degrees of freedom.

Course outcomes:

After the completion of the course the student will be able

1. Use appropriate numerical methods to solve first, second order ode and pde.
2. Appreciate how mathematics is used in design (e.g. conformal mapping)
3. Use Cauchy's integral theorem and formula to compute line integrals.
4. To apply optimization techniques in problems of engineering and technology.
5. Determine the extremals of functional and solve the problems of the Calculus of variation and formulate the variational problem.

Course Contents:

UNIT –1 Numerical Methods –III: [12 hrs]

(i)Numerical solution of simultaneous first order ODE :Picard's and Runge-Kutta method of fourth order.

(ii)Numerical solution of second order ordinary differential equations, Picards method, Runge-Kutta method and Milne's method

(iii)Numerical solutions of PDE: Finite difference approximations to derivatives, Numerical solution of two –dimensional Laplace equation, one-dimensional Heat and Wave Equations.

UNIT –2 Complex variables –I & II [12 hrs]

Function of a complex variable, Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms. Properties of analytic functions. Application to flow problems- complex potential, velocity potential, equipotential lines, stream functions, stream lines. Conformal Transformations: Bilinear Transformations. Discussion of Transformations: Complex line integrals-Cauchy's theorem and Cauchy's integral formula and problems.

UNIT-3 Optimization: [12 hrs]

Introduction, origin, scope , limitation, approach, linear programming , mathematical formulation of LPP, Graphical Method, Simplex method, Big M-method.

UNIT-4 [12 hrs]

Calculus of variations : Introduction , functional, Euler's Equation and its solution, geodesics , Isoperimetric problems , several dependent variables, functionals involving higher order derivatives, approximate solution of Boundary value problems –Rayleigh-Ritz method, Weighted residual method –Galerkin's method , Hamilton's principles, Lagrange's equations.

Text books:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43nd edition, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 10th edition, 2015.

Reference Books:

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th edition, 2013.
2. R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House,5th edition, 2014.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4200A	**MATERIAL SCIENCE AND METALLURGY**	16	HC	3	0	0	3	3
Prerequisites: Engineering Physics and Chemistry		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. The main objective of this course is to provide the basic knowledge required to explore the discipline of materials science and engineering.
2. To develop the knowledge of the structure of materials which includes crystallography, microstructure, defects, and phase diagrams
3. To give an idea about the heat treatment required for the metals
4. To incorporate the knowledge in various class of materials and their applications

Course Outcomes:

After completion of the course the student will be able to

1. Understand how materials are classified based on atomic arrangement and behavior of materials in elastic and plastic regions
2. Identify the type of failures and also to perform fatigue test
3. Identify the different phases of iron and apply required heat treatment process for the industrial purposes
4. Gain knowledge on different class of materials and their applications

Course Contents:

UNIT-1: Mechanical Behavior of Materials [12 hrs]

Stress – strain diagram for ductile and brittle materials, elastic and plastic deformation, mechanical properties in elastic and plastic region, linear and non-linear properties (no numerical)

Creep – Phenomenon, stages of creep and creep properties. Fatigue- Types of fatigue loads, fatigue properties, Fatigue test and S- N curves.

Fracture: Mechanism of fracture, ductile and brittle fracture, Griffith's theory of fracture (only derivation), ductile to brittle transition

UNIT–2: Solidification and Phase diagrams [12 hrs]

Mechanism of solidification, homogeneous and heterogeneous solidification, Hume Rothary rules substitution and interstitial solid solutions. Construction of phase diagram for two component systems, application of Gibbs phase rule. Construction of phase equilibrium diagram involving complete and partial solid solubility, application of lever rule. (with numerical), Iron carbon equilibrium diagram and invariant reactions.

UNIT-3: Heat treatment of metals & Alloys [12 hrs]

Heat treatment of metals: Annealing method and its types. Normalizing, hardening, tempering, martempering, austempering. Hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys. (Methods with applications)

UNIT-4: Smart and Composite Materials [12 hrs]

Materials exhibiting ferroelectric, piezoelectric, optoelectric, semiconducting, photo conductivity, super conductivity behavior (Examples with applications). Nanomaterials, properties and applications. Introduction to bio materials, superalloys and shape memory alloys.

Composite materials – Introduction classification, difference between conventional Production of FRP's – hand layup and spray up process, Production of MMC's – Stir casting process and spray forming process and composite materials, advantages, limitations and applications.

Text Books:

1. Foundations of Materials Science and Engineering, Smith, 4th Edition McGraw Hill, 2009
2. Materials Science, Shackleford., & M. K. Muralidhara, Pearson Publication – 2007.
3. Foundations of Materials Science and Engineering , William Smith , McGraw-Hill Science Engineering Math.
4. Material science, shackleford.,& M. K Muralidhara, Pearson Publications - 2007

Reference Books:

1. An Introduction to Metallurgy; Alan Cottrell, Universities Press India Oriental Longman Pvt. Ltd., 1974.
2. Engineering Materials Science, W.C.Richards, PHI, 1965
3. Materials Science and Engineering, V.Raghavan , PHI, 2002
4. Materials Science and Engineering,William D. Callister Jr., John Wiley & Sons. Inc, 5th Edition, 2001.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4200B	**MECHANICAL MEASUREMENTS AND METROLOGY**	16	HC	3	0	0	3	3
Prerequisites: Basic Physics		Internal Assessment		Semester End Exam				
		40 Marks		60 Marks				

Course Objectives:

1. Impart the knowledge of standards importance and conversion.
2. Define the fundamental concepts and derive the relations for the design of gauges, types of gauges, concepts involving comparators, angular measurements, screw thread and gear measurements.
3. Define the fundamental methods of measurement, concept of transducer and intermediate modifying devices and terminating devices.
4. Clear exposure to the errors, classification and remedies.
5. To explore the students to various aspects regarding the force, torque, strain, pressure and temperature measurements.
6. To identify, analyze the concept and the principle advantages and applications of the above measurements.

Course Outcomes:

After completion of the course the student will be able to

1. Students learn and understand the need, history for the development of new concepts with metrology and measurement.
2. Students will demonstrate the knowledge of standards, comparison between the standards and their conclusion.

3. Will have learnt the capability to recognize the need for measurement, the fundamental concepts of measurement, conduct the experiments and record the data and interpret the results.
4. Will have acquired the ability to recognize the concept of errors and accuracy.
5. Will have the capability to apply the skills in measuring force, torque, strain, pressure and temperature.
6. Will have acquired the ability to recognize the global, societal and ethical aspects of the work with social and ethical responsibilities as related to metrology and measurement.

Course Contents:

UNIT-1: Standards of measurement: **[12 hrs]**

Introduction, Definition and Objectives of metrology, Role of standards, Standards of length-International prototype meter, Imperial standard yard, Light wave length standard, subdivision of standards, line and end standard, comparison, calibration of end bars (Numerical), Slipgauges, Requirements and manufacture of slip gauge, Wringing phenomena, Indian Standards (M-45,M-87, M-112), Numerical problems on building of slip gauges.

Limits,Fits ,Tolerance and Gauging: Introduction, Need of limit systems, Definition of Limit and tolerance, Specification in assembly, interchangeability and selective assembly ,limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919-1963), geometrical tolerance, positional-tolerances, system of fits, Tolerance grade, Numerical problems, classification of gauges, brief concept of design of gauges (Taylor's principles),Types of gauges-plain plug gauge, ring gauge.

UNIT-2: Comparators and Angular measurement: **[12 hrs]**

Introduction to comparators, Need for a comparator, characteristics, classification of comparators, mechanical comparators- Johnson Mikrokator, sigma comparators, dial indicator, optical comparator: Principle of optical lever, Zeiss ultra optimeter, Advantages and Disadvantages, LVDT, Advantages and Disadvantages, pneumatic comparators:principle, solex comparator, Angular measurements, Vernier bevel protractor use of angle gauges (numericals on building of angles).

Interferometer, screw thread and gear measurement: Principle of interferometry, Interference pattern, optical flat, autocollimeter, Screw thread: Introduction, Terminology, types and errors. Measurement of major diameter, minor diameter,effective diameter of screw threads by 2-wire and 3-wire methods, Expression for best size wire. Tool maker's microscope, gear tooth terminology, use of gear tooth vernier caliper for thickness and depth measurement.

UNIT-3: Measurements and measurement systems: **[12 hrs]**

Introduction, Definition, Requirement of measurements, significance of measurement system, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysterisis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers. Mechanical members: Bourdon tube, Diaphragm, Bellows. Electrical members: Resistive, capacitive, piezoelectric and photoelectric transducers.

Intermediate modifying and terminating devices:
Introduction, Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers, Vacuum tube amplifiers and telemetry. Introduction to Terminating devices, Meter indicators, CRO, Measurement of frequency, oscillographs, X-Y plotters.

UNIT-4: Measurement of force, torque and pressure: [12 hrs]
Introduction, Direct method: Analytical balance, unequal arm balance, Platform balance, proving ring. Torque measurement: Mechanical, hydraulic dynamometer, Pressure measurements, principle, Bridgeman gauge, McLeod gauge, Pirani gauge .
Temperature and strain measurement: Introduction, Resistance thermometers, thermocouple, law of thermo couple, Thermocouple materials and construction, Measurement of thermal emf, pyrometer, optical pyrometer, Radiation pyrometers. Strain measurements, strain gauge, preparation and mounting of strain gauges, methods of strain measurement.

Text Books:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. Engineering Metrology, R.K. Jain, Khanna Publishers, 1994.

Reference Books:

1. Engineering Metrology, I.C. Gupta, Dhanpat Rai Publications, Delhi.
2. Mechanical Measurements, R.K. Jain Khanna Publishers, 1994.
3. Industrial Instrumentation, Alsutko, Jerry. D. Faulk, Cengage Asia Pvt. Ltd. 2002.
4. Measurement Systems Applications and Design, Ernest O. Doebelin, 5th Ed., McGraw Hill Book Co.
5. Metrology & Measurement, Anand K. Bewoor & Vinay A. Kulkarni, Tata McGraw.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4300	**APPLIED THERMODYNAMICS**	16	HC	3	1	0	4	5
Prerequisites: Basic Thermodynamics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To understand and apply concepts of thermodynamics to various energy conversion processes and systems.
2. To understand the chemical reactions involved in combustion process and energy released during the combustion.
3. To study the various aspects of IC engines, testing of engines and performance evaluation.
4. To understand the properties of air, working of air conditioner gives idea about designing the equipments for human comforts

5. To prepare students to apply various concepts in thermodynamics to solve numerical and design problems of various thermodynamic processes and systems and provide useful solution.
6. To train students about engines, working of engines, testing of engines by conducting experiments, making measurement of test parameters and analysis the test data.
7. To make students aware of the current advancements in various aspects of thermodynamics such as automobile engines, power generation systems etc,.

Course Outcomes:

1. Students can able to analyze the thermodynamic process/cycles involved in engineering applications.
2. Able to find power, efficiency and losses in thermodynamic system or devices during execution of process.
3. Analysis of various systems under different circumstances in thermodynamic point of view.
4. Able to find performance of engineering devices like IC engine, turbines, compressors, refrigerator and air-conditioner.
5. Behavior of working fluid in various thermodynamic systems.
6. Capability to apply various concepts in thermodynamics to solve numerical and design problems of various thermodynamic processes and systems and provide useful solution.
7. This subject is prerequisite for future semester subjects like Turbomachinary, heat transfer; hence he/she can study those subjects without difficulty.

Course Content:

UNIT-1 **[12 hrs]**

Combustion Thermodynamics

Theoretical (Stoichiometric) air and excess air for combustion of fuels; Mass and volume balance and actual combustion; Exhaust gas analysis, A/F ratio; Energy balance for a chemical reaction; enthalpy of formation, enthalpy of combustion and internal energy of combustion; combustion efficiency adiabatic flame temperature; Lower and higher calorific value of fuel, numerical problems.

Air Standard Cycles

Assumptions during analysis of air standard cycles; Air standard cycles like- Carnot, Otto, Diesel, Dual and Stirling cycles; Represent of cycles on P-V and T-S diagrams; Equations for efficiencies and mean effective pressures; Comparison of Otto, diesel and Dual cycles; related simple numerical problems;

UNIT-2 **[12 hrs]**

Testing of IC Engines

Performance of engines, objectives and parameters for testing of engines; Basic definitions of Indicated power, Brake power, fuel consumption, BSFC and A/F ratio; Mechanical, Thermal, Volumetric and Relative efficiencies of engines; Testing of two-stroke and four-stroke Sl and CI engines for performance; Measurement of frictional power by various methods; study on heat balance sheet and related numerical problems.

Gas Turbines and Jet Propulsion

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(no numerical); Jet propulsion and Rocket propulsion;

UNIT-3 **[12 hrs]**

Vapour Power Cycles

Simple steam power cycle; Carnot cycle and its limitations; Simple Rankine cycle; description on T-S diagram, analysis for performance; Comparison of Carnot and Rankine cycle; actual Rankine cycle; Effects of pressure and temperature on Rankine cycle performance; Ideal and practical regenerative Rankine cycles, for closed feed water heaters; Reheat Rankine cycle; Numerical problems;

Reciprocating Compressors

Classification of reciprocating compressors, Working of a single stage reciprocating air compressors; Work input per cycle without clearance and with clearance volume with PV diagram, Effect of clearance volume; Volumetric efficiency, Adiabatic, Isothermal and Mechanical efficiencies; Multi-stage compression, advantages, saving in work, condition for minimum work, inter-cooling(perfect and imperfect) minimum work for compression; Numerical problems;

UNIT-4 **[12 hrs]**

Refrigeration

Introduction, units of refrigeration, COP. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle. Vapour compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, Refrigerants and their desirable properties, commonly used refrigerants. Vapour absorption refrigeration system (no numerical on this topic). Numerical problems.

Psychrometry

Atmospheric air, moist air study of psychometric properties; Dry bulb temperature, wet bulb temperature, dew point temperature; partial pressures, specific and relative humidifies and adiabatic saturation temperature; Use of psychometric chart; Analysis of various psychometric processes; sensible heating and cooling, dehumidifying and humidifying. Summer and winter air – conditioning systems; Numerical problems.

Text Book:

1 Nag P.K. Basic & Applied Thermodynamics. Tata McGraw Hill Pub. Co. 2002.
2 Rajput R.K, Thermal Engineering. Lakshmi publications.

Reference Book

1 Yunus A. Cenegal and Michael A. Boles, “Thermodynamics -An Engineering Approach”, Tata McGraw-Hill.2002.
2 Mahesh M Rathore, “Thermal Engineering”, Tata McGraw-Hill, Prentice-hall of India Pvt. Ltd.
3 Guptha and Prakash, Engineering Thermodynamics

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.

BTME16F4400	**THEORY OF MACHINES – I**	16	HC	3	1	0	4	5
Prerequisites: Basic Mathematics, Engineering Mechanics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To familiarize students with basic types of mechanisms, joints and degrees of freedom to perform position, velocity and acceleration analysis using graphical and analytical methods.
2. To provide students an understanding of different types of mechanisms.
3. To teach the basics of synthesis of simple mechanisms.
4. To teach students the kinematic analysis of cam-follower motion and gear train configurations.

Course Outcome:

After completion of the course the student will be able to

1. Demonstrate an understanding of the concepts of various mechanisms and pairs.
2. Do velocity and acceleration analysis of simple mechanisms.
3. Design a layout of cam for specified motion.
4. Synthesis simple mechanisms for function, path generation and body guidance
5. Demonstrate an understanding of principle of gears

Course Content:

UNIT-1 **[12 hrs]**

Introduction: Links-types, Kinematics pairs-classification, Constraints-types, Degrees of freedom of planar mechanism, Grubler's equation, linkage mechanisms, inversions of four bar chain, slider crank chain and double slider crank chain.

Mechanisms with Lower Pairs: Pantograph, Exact straight line motion mechanisms-Peaucellier's, Hart and Scott Russell mechanisms, Approximate straight line motion mechanisms–Grass-Hopper, Watt and Tchebicheff mechanisms, Hooke's joint, Davis gear mechanism. Analysis of Ackermann steering gear mechanisms.

UNIT-2 **[12 hrs]**

Velocity in Mechanisms: Velocity of point in mechanism, Velocities in four bar mechanism, slider crank mechanism and quick return motion mechanism, Rubbing velocity at a pin joint, Instantaneous center method, relative velocity method Types & location of instantaneous centers, Kennedy's theorem, Velocities in four bar mechanism & slider crank mechanism.

Acceleration in Mechanisms: Acceleration of a point on a link, Acceleration diagram, Coriolis component of acceleration, Crank and slotted lever mechanism, Klein's construction for Slider Crank mechanism and Four Bar mechanism, Analytical method for slider crank mechanism

UNIT -3 **[12 hrs]**

Gears : 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, Numericals

Gear Trains: Simple, compound, reverted and planetary gear trains, Sun and planet gear. Numericals

UNIT -4 **[12 hrs]**

CAMS: Cams and Followers - Classification & terminology, Cam profile by graphical methods with knife edge and radial roller follower for uniform velocity, simple harmonic and parabolic motion of followers,

Analytical methods of cam design – tangent cam with roller follower and circular cams with flat faced follower

Text books:

1. Theory of Machines - Thomas Bevan,3rd edition,CBS publications.
2. Theory of Machines and Mechanisms- Shigley, 3rd edition Mc Graw Hill Book company
3. Theory of Machines – R S Khurmi & J K Gupta, 5th edition, S. Chand publications
4. Theory of Machines – R. K. Bansal , 6th edition, Laxmi Publications

Reference books:

1. Theory of Machines and Mechanisms-Ghosh & Mallik 3rdedition, East westpress
2. Theory of Machines-S.S. Rattan, 3rd edition, 2013,TMH publications
3. Kinematics of Machines-Dr. Sadhu singh, 2nd edition,Pearson Publication

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4500	**MANUFACTURING TECHNOLOGY – II**	16	HC	3	0	0	3	3
Prerequisites: Manufacturing Technology-I		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To study machine tools and basic machining processes.
2. To know the fundamentals of metal cutting and tool engineering.
3. To familiarize with modern machine tools.

Course Outcomes:

After completion of the course the student will be able to

1. Understand chip forming processes such as turning, milling, drilling, etc.
2. Understand the design aspects of cutting Tools and Economics of machining.
3. Distinguish between the conventional and modern machine tools.

Course Content:

UNIT –1: Theory of Metal Cutting [12 hrs]

Nomenclature of lathe tool, mechanics of chip formation, Types of Chips ,orthogonal and oblique cutting, Merchant circle diagram for cutting forces and shear angle relationship in orthogonal cutting, factors affecting tool forces, Cutting speed, feed and depth of cut, surface finish. Tool Wear and Tool failure, tool life and factors affecting, Taylor's Tool Life equation. Problems on cutting forces and tool life evaluation.

Cutting Tool Materials and Cutting fluids: Characteristics of tool materials, various types of cutting tool materials, cutting tool selection, Purpose and types of cutting fluids, effect of cutting fluid on tool life, selections of cutting fluid. Heat generation in metal cutting, factors affecting heat generation, Heat distribution in tool and work piece and chip, Measurement of tool tip temperature using tool work thermocouple technique.

UNIT–2: Turning (Lathe), Shaping and Plaining Machines: [12 hrs]

Introduction, Classification of lathes, different operations on lathe, Specifications of lathe, Constructional features of Turret and Capstan lathe. Shopping and planning machines-principle, classification, Construction and working, Specification, Simple Problems on Machining time calculations.

Drilling and Boring Machines: Principles of working, specifications, classification, construction and working of bench and radial drilling machine, operations performed– twist drill – Types of twist drill & drill bit nomenclature, drill materials, Calculations in drilling. Introduction to CNC machines - Principles of operation, Advantages and disadvantages of CNC. Axes of NC machine-Coordinate systems.

UNIT -3: Milling Machines & Grinding Machines: [12 hrs]

Milling machine – Principles of working – specifications – classifications of milling machines – Construction and working of horizontal, vertical and universal milling machines, Comparison between upmilling and Down milling, milling operations, geometry of milling cutters –methods of indexing Simple and compound, indexing. Simple problems on simple and compound indexing.

Grinding Machines: Introduction, Principle of working, Grinding machine –classification and constructional teatures of cylindrical, Centreless and surface grinding machine –Different types of abrasives, Grain size, bonding processes, grade and structure of grinding wheels, grinding wheel types and selection of a grinding wheel , Grinding process parameters. Dressing and truing of grinding wheels.

UNIT -4: Lapping, honing and broaching machines [12 hrs]

Lapping and Honing operations – Principles, arrangement of set up and application. Super finishing process, polishing, buffing operation and application

Broaching: Principle of broaching, Details of a broach. Types of broaching machines-constructional details. Applications, Advantages and Limitations.

Non Traditional machining: Need of NTM processes, Differences between conventional and non conventional machining processes.Abrasive jet machining: Principles, applications, process parameters. Ultrasonic machining: Principles, applications, analysis of process parameters. Electric discharge machining: Principles, selection of tools materials and dielectric fluid. Electron beam machining: Generation of electron beam, relative merits and demerits. Laser beam machining: Principles and applications.

Text Books:

1. Workshop Technology, Hazara Choudhry, Vol-II, Media Promoters & Publishers Pvt. Ltd. 2004
2. Production Technology, R.K.Jain, Khanna Publications, 2003.
3. Production Technology, HMT, Tata Mc Graw Hill, 2001.

Reference Books:

1. Manufacturing Science, Amitabha Ghosh and Mallik, affiliated East West Press, 2003.
2. Fundamentals of Metal Machining and Machine Tools, G.Boothroyd, McGraw Hill, 2000. 3. Principles of Machine Tools – G.C. Sen & A. Bhattacharya, Tata McGraw Hill, New Delhi
3. Manufacturing Engg. & Tech, Kalpakian, Serope Addison -Wisly Publishing Co.New York.
4. Modern Machining Processes: P.C. Pandey & H.S. Shan, T.M.H. Company, New Delhi
5. Text Book of Production Engineering: P.C. Sharma, S.Chand & Sons
6. Manufacturing Technology – Metal cutting and machine Tools: P.N. Rao, T.M.H, New Delhi

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4600A	**COMPUTER AIDED MACHINE DRAWING**	16	HC	1	0	2	3	5
Prerequisites: Computer Aided Engineering Drawing		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Understand drawing and develop capacity to represent any matter/object with the help of picture.
2. Develop primary knowledge of working drawing.
3. Produce orthographic drawing of different machine parts.
4. Develop skill to produce assembly drawings.

Course Outcomes:

After completion of the course the student will be able to

1. Capability of understanding the graphical language.
2. Draw detailed schematic and simplified drawings in sections and elevation using ANSI standards.
3. Be able to analyze and design common machine elements.
4. Become more familiar with the range and function of common machine elements.
5. Students should be able to apply this knowledge to generating new, innovative design

Course Content:

UNIT–1: Introduction to Geometrical Tolerance and Dimensioning (GD&T) [12 hrs]

Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings).

Thread Forms: Thread terminology, sectional views of threads: ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.

UNIT -2: [12 hrs]

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

Keys & Riveted Joints : Parallel key, Taper key, Feather key, Gibhead key and Woodruff key. Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets).

UNIT -3: [12 hrs]

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

Couplings: Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)

UNIT –4: [12 hrs]

Assembly Drawing: Screw jack (Bottle type), Machine vice, Plummer block (Pedestal Bearing), I.C. Engine connecting rod, Tailstock of lathe, Tool Head of a shaper, Rams Bottom Safety Valve, Feed Check Valve.

Text Books:

1. 'Machine Drawing', K.R. Gopala Krishna, Subhash Publication, Bangalore,2013
2. 'Machine Drawing', N.D.Bhat & V.M.Panchal

Reference Books:

1. ' A Text Book of Computer Aided Machine Drawing', S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007.
2. ' CAD for engineers and designers', Sham Tickoo. Dream tech 2005
3. 'Machine Drawing', N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata McGraw Hill,2006

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4600B	**FLUID MECHANICS**	16	HC	2	1	0	3	4
Prerequisites: Basic Physics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To give an introduction and explain basic fundamentals of fluid mechanics. Also to learn fluid properties and pressure measurements
2. To incorporate concepts of stability of floating and submerged bodies which are essential in the field of shipping industries. To gain the knowledge of kinematics and dynamics of the fluids.
3. To know the applications of Bernoulli's equation like flow measuring devices, dimensional analysis and also the flow behavior and losses in the pipes
4. The know the importance of Reynolds number, boundary layer theory and also to give an introduction to compressible and Navier stokes equation

Course Outcomes:

After completion of the course the student will be able to

1. Utilize the properties of fluid and pressure concepts for various practical purposes
2. Find the stability and comfort conditions of the marine vehicles. To use the concepts of Bernoulli equation and continuity equation for the various engineering purposes
3. Find the dependent and independent parameters for a model of fluid flow, analyze the model and the prototype and also design the flow through pipes
4. Distinguish the laminar and turbulent flows, apply the knowledge of lift and drag forces in aerospace industries

Course Content:

UNIT-1: **[12 hrs]**

Properties of Fluids: Introduction, types of fluid, properties of fluids, viscosity, compressibility, surface tension, capillarity.

Fluid Statistics: Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple and differential manometers. Total pressure and center of pressure on submerged plane (horizontal, vertical and inclined) surfaces.

UNIT -2: **[12 hrs]**

Buoyancy, center of buoyancy, metacentre and metacentric height, equilibrium conditions of floating and submerged bodies, determination of Metacentric height experimentally and theoretically. Kinematics: Types of fluid flow, continuity equation in 2D and 3D (Cartesian Co-ordinates only), velocity and acceleration, velocity potential function and stream function , simple problems.

Fluid Dynamics: Introduction equation of motion, Euler's equation of motion, along stream line and Bernoulli's equation, limitations of Bernoulli's equation, simple problems..

UNIT -3: **[12 hrs]**

Fluid Flow Measurements : Venturi meter, orifice meter, pitot-tube, V-Notch and rectangular notches, Dimensional Analysis : Introduction, Rayleigh's method, Buckingham theorem, dimensionless numbers(only theory).

Flow through pipes : Minor losses through pipes(no derivations). Darey's and Chezy's equation for loss of head due to friction in pipes. HGL and TEL, simple numerical.

UNIT -4: **[12 hrs]**

Laminar flow : Reyonold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. Flow past immersed bodies : Drag, Lift, expression for lift and drag, boundary layer theory, definitions and expressions of displacement, momentum and energy thickness.

Text Books:

1. Fluid Mechanics, Dr. Bansal, R.K.Lakshmi Publications, 2004.
2. Hydraulics and Fluid Mechanics Including Hydraulics Machines, P.N Modi and S.N Seth,,19 Edition Standard Publishers Distributors (2013)

Reference Books:

1. Fluid Mechanics (SI Units), Yunus A. Cengel John M.Oimbala, 2nd Ed., Tata McGraw
2. Hill, 2006.
3. Fluid Mechanics, Oijush.K.Kundu, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005.
4. Fluid Mechanics and hydraulics, Dr.Jagadishlal: Metropolitan Book Co-Ltd., 1997.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4700A	**MATERIALS SCIENCE LAB**	16	HC	0	0	2	2	3
		Internal Assessment			Semester End Exam			
Prerequisites: Material Science		20 Marks			30 Marks			

Course Objectives:

1. To prepare the specimen for metallographic examination
2. To study the wear characteristics of the given specimen
3. To study the tensile , compressive and shear prosperities of metals and non metals
4. To evaluate Brineel, Vicker's and Rockwell's hardness of the materials
5. To find impact strength of the given material
6. To find the endurance limit of the material

Course Out comes:

After completion of the course the student will be able to

1. Identify the type of material based on the microstructure using optical microscope.
2. Carry out wear test to find wear prosperities.
3. Find out the defects in the given specimen using Ultrasonic flaw detection, Magnetic crack detection and Dye penetration test.
4. Find out tensile, compressive, torsional and bending properties of the given material using UTM.
5. Find hardness of the given material
6. Find impact strength of the given material.

Course Content:

PART – A

1. Preparation of specimen for Metallograpic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.
2. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
3. Non-destructive test experiments like,
   a. Ultrasonic flaw detection
   b. Magnetic crack detection
   c. Dye penetration testing. To study the defects of Cast and Welded specimens

PART – B

1. Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine
2. Torsion Test
3. Bending Test on metallic and nonmetallic specimens.
4. Izod and Charpy Tests on M.S, C.I Specimen.
5. Brinell, Rockwell and Vickers's Hardness test.
6. Fatigue Test.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4700B	**METROLOGY AND MEASUREMENT LAB**	16	HC	0	0	2	2	3
Prerequisites: Basic Physics		Internal Assessment 20 Marks			Semester End Exam 30 Marks			

Course Objectives:

1. Educate students on different measurement systems and on common types of errors.
2. Introduce different types of sensors, transducers and strain gauges used for measurement.

3. Give knowledge about thermocouples, thermometers and flow meters used for measurements
4. Introduce measuring equipment's used for linear and angular measurements.
5. Familiarize students with surface roughness measurements on machine components

Course Out comes:

After completion of the course the student will be able to

1. Choose the proper measuring instruments for the measurement of pressure, Force, temperature, linear distance, speed, surface finish etc., using calibration technique
2. Measure the depth and thickness of the given gear tooth using gear tooth Vernier caliper.
3. Demonstrate the measurement of cutting forces, thread components, angular components.
4. Recognize screw thread parameters using floating carriage measuring machine
5. Analyze tolerance of drilled components using mechanical comparator Work in Quality control and quality assurances divisions in industries
6. Distinguish the various interference patterns by using optical flat.

Course Content:

PART-A: MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART-B: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using
   a) Lathe tool Dynamometer
   b) Drill tool Dynamometer.
5. Measurement of Screw threads Parameters using Two wire or Three-wire method.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer
8. Calibration of Micrometer using slip gauges
9. Measurement using Optical Flats

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4800A	**MANUFACTURING TECNOLOGY LAB**	16	HC	0	0	2	2	3

Prerequisites: Concept on forging and foundry	Internal Assessment	Semester End Exam
	20 Marks	30 Marks

Course Objectives:

1. The course will introduce desirable properties of molding sand and establish its relevance in preparing the sand mold.
2. To introduce the experimental procedure in determining the GFN, Permeability, Strength of mold, moisture & clay content in sand sample, core hardness & mold hardness.
3. To bring in the effect of clay & water content on the various properties of molding sand.
4. To give students hands on practice in preparing the sand moulds (Cope & Drag box) using single piece, split pattern and without using pattern.
5. To give students hands on practice in preparing forging models using open -hearth furnace by performing upsetting, drawing & bending operation.

Course Out comes:

After completion of the course the student will be able to

1. Describe general properties of molding sand.
2. Illustrate the influence of Grain fineness of the silica sand used in the preparation of the mold
3. Determine the compression, shear, tensile strength & permeability of a molding sand for different proportion of clay.
4. Determine the percentage of clay & moisture content for a given sand sample
5. Identify the different tools used in foundry & Forging practice with their uses
6. List the different stages involved in preparing the sand mold box & forged model
7. Create the sand mold cavity using cope & drag box with pattern or without pattern
8. Demonstrate the upsetting, drawing & bending operation in preparing the forged model

Course Content:

PART – A

1. Testing of Moulding sand and Core sand:

Preparation of sand specimens and conduction of the following tests:

a) Compression, Shear and Tensile tests on Universal Sand Testing Machine.
b) Permeability test
c) Core hardness & Mould hardness tests.
d) Sieve Analysis to find Grain Fineness number of Base Sand
e) Clay content determination in Base Sand

PART – B

2. Foundry Practice

a) Use of foundry tools and other equipments.
b) Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).
c) Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART – C

3. Forging Operations:

a) Calculation of length of the raw material required to do the model.
b) Preparing minimum three forged models involving upsetting, drawing and bending operations.
c) Out of these three models, at least one model is to be prepared by using Power Hammer.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F4800B	**MACHINE SHOP**	16	HC	0	0	2	2	3
		Internal Assessment		Semester End Exam				
Prerequisites: Manufacturing Technology		20 Marks		30 Marks				

Course Objectives:

1. To understand various operations carry out through various machines.
2. To provide knowledge about various machine tools.
3. To learn turning, milling and shaping operations.
4. To prepare the model as per the given dimensions

Course Out comes:

After completion of the course the student will be able to

1. Identify the various operations require to prepare the model.
2. Select the suitable machine for a particular operation.
3. Prepare the specimen as per the given dimension for the given raw material.
4. Work in a manufacturing industry.

Course Contents:

Part-A

Preparation of various models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART-B

Cutting of V Groove/ dovetail/Rectangular groove using a shaper.

Cutting of Gear Teeth Using Milling Machine

FIFTH SEMESTER

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5100A	**TURBOMACHINERY**	16	HC	3	1	0	4	5
Prerequisites: Fluid Mechanics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To provide a sound understanding of the comparison of positive displacement machine and Turbo machine.
2. To provide knowledge about impact of jet on vanes.
3. To provide an understanding of energy transfer in turbo machinery.
4. To provide knowledge about general analysis of radial flow turbo machines.
5. To provide knowledge about general analysis of axial flow turbo machines.
6. To provide knowledge of design of hydraulic turbines and its characteristics.
7. To provide knowledge about design of centrifugal pumps
8. To provide knowledge of flow through nozzles.
9. To provide knowledge of design of steam turbines.

Course Outcome:

After completion of the course the student will be

1. Able to differentiate positive displacement machines and turbo machines.
2. Able to explain of Euler turbine equation and velocity triangles.
3. Able to draw velocity triangles of axial flow turbines and compressors.
4. Able to Analyze hydraulic turbines and centrifugal pumps.
5. Able to conduct performance test on various types of hydraulic turbines and pumps.

Course Content:

UNIT -1: **[12 hrs]**

Introduction: 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. Illustrative examples.

Impact of jets: Introduction, Force exerted by the jet on a stationary vertical plate, symmetrical and unsymmetrical curved vane at centre and tangentially at one of the tip. Force exerted by the jet on a moving vertical plate, force exerted by jet of water on unsymmetrical moving curved vane when jet

strikes at centre and tangentially at one of the tips. Force exerted by a jet of water on series of plate (condition for maximum efficiency). Illustrative examples.

UNIT -2: Energy Transfer in Turbo Machine: **[12 hrs]**

Euler Turbine equation; Alternate form of Euler turbine equation – components of energy transfer; Degree of reaction, Utilization factor, Vane efficiency; Relation between utilization factor and degree of reaction; Velocity triangles for different values of degree of reaction for axial flow turbines, Velocity triangles and condition for maximum utilization factor – optimum blade speed ratio for different types of turbine. Comparison of Energy transfer, Illustrative examples.

General analysis of Power absorbing turbo machines– General analysis of axial flow Compressors and pumps , velocity triangles and general expression for degree of reaction, 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. Illustrative examples.

UNIT -3: Hydraulic Turbines: **[12 hrs]**

Classification; Different efficiencies; Pelton Turbine-velocity triangles, condition for maximum efficiency, Design parameters; Francis turbine-velocity triangles, Design parameters; Function of a Draft tube, types of draft tubes; Kaplan and Propeller turbines – Velocity triangles and Design parameters. Illustrative examples.

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel, Illustrative examples.

UNIT-4: **[12 hrs]**

Steam Nozzles: Type of Nozzles- Flow Through Nozzles- Condition for Maximum Discharge- Nozzle Efficiency- Super Saturated Flow in Nozzles- Relationship Between Area Velocity and Pressure in Nozzle Flow. Illustrative examples.

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Reaction turbine – Parsons's turbine, condition for maximum utilization factor. Illustrative examples.

Text Books:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008.
2. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002

Reference Books:

1.Principals of Turbomachines, D. G. Shepherd, The Macmillan Company (1964).
2.Fluid Mechanics & Thermodynamics of Turbomachines, S. L. Dixon, Elsevier (2005).
3.Turbomachine, B.K.Venkanna PHI, New Delhi 2009.
4. Text Book of Turbomachines, M. S. Govindgouda and A. M. Nagaraj, M. M. Publications, 4Th Ed, 2008.
5.Thermal Engineering, by R.K.Rajput., Laxmi Publications

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5100B	**FINITE ELEMENT METHOD**	16	HC	3	1	0	4	5
Prerequisites: Mathematics, Numerical Methods, SOM		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To enable the students understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics, heat transfer and fluid flow problems.
2. Provide systematic and comprehensive knowledge of basics of Finite element method as an analysis tool.
3. To teach the students the characteristics of various elements and selection of suitable elements for the problems being solved.
4. To make the students derive finite element equations for simple and complex elements.

Course Outcome:

After completion of the course the student will be able to

1. Understand the different types of analysis methods
2. Analyze the bar and beam problems by Euler-Lagrange equations
3. Understand principle of minimum potential energy
4. Analyze the bar problems using elimination and penalty approach
5. Apply Lagranage's equation for Higher order elements
6. Solve truss problems using elimination approach
7. Derive Hermite Shape function and apply it to solve beam problems
8. Apply FEM method to solve 1D heat transfer problems

UNIT – 1 **[12 hrs]**

Introduction: Introduction to finite difference method and finite elements method, Advantages and limitations, Mathematical formulation of FEM, Steps involved in FEM, Different approaches in Finite Element Method - Direct Stiffness approach, simple examples, Variational approach, Elements of variational calculus -Euler Lagrange equation, Rayliegh Ritz method, Weighted Residual methods, Galarkin method.

UNIT – 2 **[12 hrs]**

Interpolation Models: Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular element.

Solution of 1-D Bars: Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique.

UNIT –3 **[12 hrs] Higher Order Elements:** Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Iso parametric, Sub parametric and Super parametric elements. Numerical integration : 1 and 2 gauge point for 1D case.

Trusses: Stiffness matrix of Truss element. Numerical problems

UNIT – 4 **[12 hrs] Beams:** Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads.

Heat Transfer: Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction. Galerkin's approach for heat conduction.

Text Books:

1. **Finite Elements in Engineering**, T.R.Chandrupatla, A.D Belegunde, 3rd Ed PHI.
2. **Finite Element Analysis**, S.S. Bhavikatti, New Age International publishers,2006

Reference Books:

1. **"Finite Element Methods for Engineers"** U.S. Dixit, Cengage Learning, 2009
2. **Concepts and applications of Finite Element Analysis**, R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, Wiley 4th Ed, 2009
3. **Finite Element Methods**, Daryl. L. Logon, Thomson Learning 3rd edition, 2001.
4. **Finite Element Method**, J.N.Reddy, McGraw -Hill International Edition.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5200A	**THEORY OF MACHINES-II**	16	HC	3	1	0	4	5
Prerequisites: Theory of Machine-I, Engineering Mechanics, Strength of Materials		Internal Assessment				Semester End Exam		
		40 Marks				60 Marks		

Course Objectives:

1. To understand the synthesis and analysis of common mechanisms and concepts of turning moment diagrams, flywheel design
2. To understand the dynamics of engines, balancing of rotating and reciprocating masses, rotors and engines.
3. To study and realizations of speed control devices and their characteristics

4. To understand the working of mechanisms based on friction and its application
5. To develop the techniques of complete anatomy of all machineries

Course Outcomes:

After completion of the course Student will be able to

1. Perform dynamic analysis of mechanisms like slider crank mechanism, four bar mechanism, IC engine and steam engine.
2. Do balancing of masses in rotation as well as reciprocating masses, rotors and engines.
3. Analyze and design of different types of governors and calculate gyroscopic couple.
4. Calculate frictional torque in different bearings, brakes and dynamometers and analyze belt drives.
5. Formulate the dynamic analysis of various machines like IC engine, steam engine, governors, gyroscopes, rotating masses, dynamometers.

Course Content

UNIT -1 **[12 hrs]**

Static & Dynamic Force Analysis : Static equilibrium of two/three force members, Static equilibrium of member with two forces and torque, Static force analysis of linkages, D'Alembert's principle, Equivalent offset inertia force, Dynamic force analysis of four link mechanism and slider crank mechanism, Engine force analysis- Piston and crank effort

Turning Moment & Flywheel: Turning moment on crankshaft, Turning moment diagrams-single cylinder double acting steam engine, four stroke IC engine and multi-cylinder steam engine, Fluctuation of energy, Design of Flywheel.

UNIT -2: **[12hrs]**

Balancing of Machines: Balancing of rotating masses: Static and dynamic balancing, Balancing of several masses in the same plane and different planes,

Balancing of reciprocating masses: Balancing of primary force in reciprocating engine, Partial balancing of two cylinder locomotives, inline and V-engine, Swaying couple, hammer blow. Numerical

UNIT -3: **[12 hrs]**

Governors: Introduction, Principles, Types of governors, Terminology, Porter & Hartnell governor, Sensitivity, Stability, Hunting, Isochronism, Effort and Power of governor, controlling force diagrams. Numerical.

UNIT -4: **[12 hrs]**

Gyroscopic Motion: Principles, Gyroscopic torque, Effect of gyroscopic couple on the stability of aero planes, ship & automobiles (two & four wheelers).

Text books:

1. Theory of Machines - Thomas Bevan,3rd edition,CBS publications.

2. Theory of Machines and Mechanisms- Shigley, 3rd edition Mc Graw Hill Book company
3. Theory of Machines – R S Khurmi & J K Gupta, 5th edition, S. Chand publications
4. Theory of Machines – R. K. Bansal , 6th edition, Laxmi Publications

Reference books:

1. Theory of Machines and Mechanisms-Ghosh & Mallik 3rdedition, East west press
2. Theory of Machines-S.S. Rattan, 3rd edition, 2013,TMH publications
3. Kinematics of Machines-Dr. Sadhu Singh, 2nd edition, Pearson Publication

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5200B	**HEAT AND MASS TRANSFER**	16	HC	3	1	0	4	5
Prerequisites: Thermodynamics & Fluid Mechanics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Provide sound understanding of the basic principles and laws governing the heat and mass transfer.
2. To familiarize with the various modes of heat transfer, combined heat transfer processes and special heat transfer processes.
3. To provide capability to analyze and solve practical problems from basic principles and provide numerical solutions.
4. To analyze complex heat transfer problems and provide solutions using heat transfer data hand book.
5. Carryout analysis of boiling and condensation phenomenon and design heat transfer equipments.
6. Conduct experiments related to various heat transfer processes and heat exchangers and analyze measurement data.

Course Outcome:

After completion of this course the students will be able to

1. Understanding of the basic principles and laws governing the heat and mass transfer.
2. Knowledge of the various modes of heat transfer, combined heat transfer processes and special heat transfer processes and its application.
3. Capability to analyze and solve practical problems from basic principles and provide numerical solutions.
4. Capability to analyze complex heat transfer problems and provide solutions using heat transfer data hand book.
5. Capability to analyze and provide solutions for the design of heat transfer equipment.
6. Familiarization with the experimental methodology and ability to solve problems.

Course Content

UNIT -1: **[12 hrs]**

Introduction: Modes of Heat Transfer, Basic Laws of Heat Transfer, Overall Heat Transfer Coefficient, thermal contact resistance, Boundary Conditions, 3-D Conduction Equation in Cartesian Coordinates, Discussion On 3-D Conduction Equation in Cylindrical and Spherical Coordinate Systems (No Derivation). 1-D steady state heat conduction without heat generation through plane slabs, cylinders and spheres with uniform thermal conductivity (no derivation). Heat transfer through composite wall, cylinder and sphere and applications, contact thermal resistance. Numerical.
critical thickness of insulation without heat generation. Theory of Fins-Types of fins, Governing equations for different conditions of fins(no derivations), Fin effectiveness and fin efficiency, Numerical examples. One –Dimensional Transient Conduction: Lumped parameter Analysis, Use of Heisler's Charts for transient conduction in plane slab, long cylinder and sphere. Numerical examples.

UNIT -2: **[12 hrs]**

Concepts and basic relations in boundary layers: Hydrodynamic and thermal boundary layers over flat plate, critical Reynolds number, local heat transfer coefficient, average heat transfer coefficient, Flow inside a duct, hydrodynamic and thermal entrance lengths.
Natural or Free convection: Application of dimensional analysis for free convection –physical significance of Grasshoff number, use of correlations in free convection for horizontal, vertical flat plates, cylinders and spheres. Numerical examples.
Forced convection heat transfer: Application of dimensional analysis for forced convection problems. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of correlations for hydro-dynamically and thermally developed flows in case of a flow over a flat plate, a cylinder and sphere. Numerical examples.

UNIT -3: **[12 hrs]**

Radiation Heat Transfer: Thermal radiation; definitions of various terms used in radiation heat transfer; Stefan-Boltzmann law, Kirchhoff's law, Planck's law and Wien's displacement law. Radiation heat exchange between two parallel infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle; Lambert's law; radiation heat exchange between two finite surfaces configuration factor or view factor. Numerical problems.
Mass transfer: Definition and terms used in mass transfer analysis, Fick's First law of diffusion , (no numerical).

UNIT -4: **[12 hrs]**

Heat Exchangers: Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical examples.
Condensation And Boiling: Types of condensation (discussion only) Nusselt's theory for laminar condensation on a vertical flat surface(no derivations) use of correlations for condensation on vertical flat surfaces, horizontal tube and horizontal tube banks; Reynolds number for condensate flow; regimes of pool boiling, pool boiling correlations. Numerical examples.

Text books:

1. Heat & Mass transfer, Tirumaleshwar, Pearson education 2006
2. Heat transfer-A basic approach, Ozisik, Tata McGraw Hill 2002

Reference books:

1. Heat transfer, a practical approach, Yunus A- Cengel Tata Mc Graw Hill
2. Principles of heat transfer, Kreith Thomas Learning 2001
3. Fundamentals of heat and mass transfer, Frenk P. Incropera and David P. Dewitt, John Wiley and son's.
4. Heat transfer, P.K. Nag, Tata McGraw Hill 2002.
5. Heat and mass transfer, Mahesh M Rathore, Laxmi publications.
6.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5300	**MACHINE DESIGN-I**	16	HC	3	1	0	4	5
Prerequisites: Engineering Mechanics, Material Science, Strength of Materials		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To introduce the students to the fundamental concepts of the mechanical design and to various codes and standards related to engineering materials.
2. To make the students to learn about the usage of Design Data Hand book.
3. To carry out the design of various machine members subjected to static, impact and fatigue loads.
4. To understand the importance of design of shaft subjected to torsion, bending etc.,
5. To get acquainted with the design process of various machine members like keys, joints, couplings,
   Riveted and welded joints, threaded fasteners, power screws.

Course Outcome:

After completion of this course the student will be able to

1. Better understanding of fundamental concepts related to the mechanical design.
2. Knowledge about the design of various machine elements subjected to static, impact and fatigue loads.
3. Detailed procedure of the design process of machine members like keys, joints, couplings, riveted and welded joints, threaded fasteners, power screws.

Course Content

UNIT- 1 **[12 hrs]**

Introduction: Types of mechanical engineering designs, Design Cycle, Engineering Materials and their mechanical properties, Selection of suitable materials for design, Design considerations, Codes and Standards (BIS designation of materials), Meaning of normal, shear, biaxial and tri axial stresses, Principal Stresses.

Design against Static & Impact Strength: Factor of safety, Theories of failure-Numerical, Stress concentration-Determination of Stress Concentration factor. Impact Strength- Introduction, Impact stresses due to axial, bending and tensional loads- Numerical.

UNIT- 2 **[12 hrs]**

Design against Fatigue Strength: Introduction, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Modifying factors: size effect, surface effect, effect of notch sensitivity, Design based on Soderberg's and Goodman's relationship, fatigue design under combined loading,- Numerical.

Design of Shafts: Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under combined loads (Bending & Tensional), Simple Numerical.

UNIT- 3 **[12 hrs]**

Threaded Fasteners: Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners subjected to static loads, Design of eccentrically loaded bolted joints.

Cotter and Knuckle Joints, Keys and Couplings: Design of Cotter and Knuckle joints, Keys: Types of keys, Design of keys,

Couplings: Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling.

UNIT- 4 **[12 hrs]**

Riveted and Welded Joints – Types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Lozanze Joints, Riveted Brackets. Welded Joints – Types, Strength of butt and fillet welds, eccentrically loaded welded joints.

Power Screws: Mechanics of power screw, Stresses in power screws, efficiency and self-locking, Design of Power Screw, Design of major parts of Screw Jack.

Text Books:

1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Machine Design, R.S. Khurmi & J.K.Gupta, S. Chand Publications.

Reference Books:

1. Machine Design, Dr.P.C.Sharma & Dr.D.K.Agarwal,S.K.Kataria and Sons, New Delhi.
2. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2009.

Design Data Handbook:

1. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed.
2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication
3. Design Data Hand Book, H.G. Patil, I. K. International Publisher, 2010.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5400	**HYDRAULICS & PNEUMATICS**	16	HC	3	0	0	3	3
Prerequisites: Fluid Mechanics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives

1. To provide a sound understanding of the working of hydraulic and pneumatic systems.
2. To provide an understanding of energy transfer in hydraulic actuators and motors
3. To provide knowledge about controlling components of hydraulic and pneumatic systems.
4. To provide knowledge of design of hydraulic and pneumatic systems and analyze them.
5. To introduce the concept of signal processing elements and control.

Course Outcomes

After completion of the course student will be able to

1. Get knowledge about working of hydraulic and pneumatic systems.
2. Become aware about controlling components of hydraulic and pneumatic systems.
3. Have good understanding in selection, preparation and distribution of compressed air.
4. Be capable to compile the design of hydraulic and pneumatic systems and analyze them.
5. Demonstrate the need of pressure and time dependent controls.

Course Content

UNIT -1 Fluid Power Systems and Fundamentals [12 hrs]

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law, Structure of Hydraulic System.

UNIT -2 Hydraulic System & Components [12 hrs]

Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, Piston pump, construction and working of pumps – pump performance – Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting

UNIT -3 Pneumatic Systems and Components [12 hrs]

Pneumatic Components: Properties of air – Compressors – Filter, Regulator, Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumatic and Hydraulic circuit

UNIT -4 Design of Pneumatic Circuits [12 hrs]

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.

Text Books:

1. Anthony Esposito, Fluid Power with Applications, Pearson Education 2000.
2. Majumdar S.R., Oil Hydraulics, Tata McGraw-Hill, New Delhi 2009.

References:

1. Majumdar S.R., Pneumatic systems – Principles and maintenance, Tata McGraw Hill, New Delhi 2005.
2. Anthony Lal, Oil hydraulics in the service of industry, Allied publishers, 1982.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5500	**PRINCIPLES OF MANAGEMENT**	16	HC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objective

1. The course is to provide the students, with an opportunity to gain the knowledge in the field of management by its history, evolution, functions and theories.
2. To learn the effective methods of better utilization of resources (men, machine, material and money) for the successful enterprise.
3. The aim of the course is to provide the students, with an opportunity to gain the knowledge in the field of entrepreneur, entrepreneurship and management of resources.
4. The student learns the function, types, role of entrepreneur in economic growth of a country. And also studies the different stages of entrepreneurial process.
5. The course is to provide the students, with an opportunity to gain the knowledge to start up small scale industries with the support (consultancy & finance) from government, institutes & others.
6. To learn the effect of WTO/GATT and government policies (industrial policy regulations) on small scale industries for their development.
7. To learn the project identification, project selection & project formation by following guide lines of planning commission.
8. To learn the methods of analysis of the project (interns of market, technical, financial & social feasibility study) and put it in the report form

Course Outcome

1. Students should understand the necessity of management in the field if engineering
2. Students should realize the importance of entrepreneurship in the modern world

3. Students should understand the definition, characteristics and role of SSI in economic development. Impact of privatization and globalization on SSIs.
4. Students should understand the meaning of project and project identification.
5. They should analyse the parameters of project like project appraisal, identification of business opportunities, market feasibility study, technical feasibility study etc.
6. Students should understand the concept of management as a science, art and profession.
7. They should appreciate the role of planning in management.
8. To understand the basic function of management such as planning, organizing, staffing, recruitment, directing, controlling etc.
9. To know about the procedure, support available from various agencies, Govt to start SSI.
10. To understand the requirement to become a good manager in order to manage the organization in a better way.

Course Content

UNIT -1: **[12 hrs]**

Management- Introduction, Meaning, nature and characteristics of management. Scope & functional areas of management. Management as a science, art or profession. Management and Administration, Role of management, Levels of management, early management approaches, and Modern management approaches

Planning-Nature, Importance and purpose of planning process, Objectives, types of plans (meaning only) Steps in planning, Planning premises, Hierarchy of plans

UNIT -2: **[12 hrs]**

Organizing and Staffing-Nature and purpose of organization, Principles of organization, Types of organization – Departmentation, Committees – centralization V/s decentralization of authority and responsibility, Span of control- MBO and MBE, Nature and importance of staffing, Process of selection and recruitment

Directing & Controlling-Meaning and nature of directing, leadership styles, Motivation theories, Communication- meaning and importance, Co-ordination, meaning and importance, techniques of coordination, Meaning and steps in controlling, Essentials of a sound control system, methods of establishing control.

UNIT -3: **[12 hrs]**

Entrepreneurship-Meaning of entrepreneur, evaluation of the concept, function of an entrepreneur, types of entrepreneur, entrepreneurship, concept of entrepreneurship, evolution of entrepreneurship, development of entrepreneurship, Stages in entrepreneurial process, Role of entrepreneurs in economic development entrepreneurship in India, Entrepreneurship - its barriers, limitations of entrepreneurs. **Small Scale Industry**:

Definition, characteristics, types, role of SSI in economic development. Steps to start an SSI – Govt. policy towards SSI, different policies of SSI, Govt. support for SSI, Impact of liberalization, privatization, globalization on SSI, Effect of WTO/ GATT, supporting agencies of Govt. for SSI, Ancillary industry and tiny industry (Definitions and objectives only)

UNIT -4: **[12 hrs]**

Institutional Support-Different Schemes, TECKSOK, KIADB, KSSIDC, KSIMC, DIC, Single window Agency, SISI, NSIC, SIDBI, KSFC.

Preparations for a Project-Meaning of Project; Project Identification Project Selection, Project Report, Need and significance of Report, contents, Formulation Guidelines by Planning Commission for Project report, Network Analysis; Errors of Project Report, Project Appraisal, Identification of Business Opportunities, market Feasibility Study, Technical Feasibility study, Financial Feasibility Study & Social Feasibility study.

Text Books:

1. Principles of Management, PC Tripati, P N Reddy,–Tata Mc Graw Hill, 3rd edition 2005.
2. Dynamics of Entrepreneurial Development & Management, Vasant Desai Himalaya Publishing House, 2nd edition 2006
3. Entrepreneurship Development–small Business Enterprises Poornima M Charanthmath, Pearson Education –3rd edition 2005

Reference Books:

1. Management Fundamentals, Robert Lusier–Concepts, Application, Skill Development, 1st edition. 2006
2. Entrepreneurship Development, S S Khanka S Chand & Co, 4th edition2005 Management, Stephon Robbins Pearson Education/PHI 17th Edition 2003.
3. Principles of Management by Koontz and O'Donnell, TMH
4. Management – Stephen Robbins – Pearson Education/PHI – 17th

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5610	**INTERNAL COMBUSTION ENGINES**	16	HC	3	0	0	3	3
Prerequisites: Basic concept on IC engines		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course objectives:

1. To introduce students to the working of spark ignition and compression ignition engines.
2. To teach students about the usage of alternate fuels for IC engines.
3. To enhance the understanding of students in engine emissions, pollution and their control.
4. To introduce students to the recent trends in IC Engines like stratification, multi point injection, plasma ignition etc

Course Outcome:

After the completion of the course Student will be able to:

1. Determine performance and combustion characteristics of SI and CI engines.
2. Identify the usage of alternate fuels and power plants for automobiles.

3. Determine emissions from SI and CI engines.
4. Demonstrate the ability to enhance the efficiency and performance of IC engines.

Course Content:

UNIT -1: **[12 hrs]**

Spark Ignition Engines: Spark ignition Engine mixture requirements - Feedback Control Carburetors –Properties of Fuel - Injection systems –Mono point and Multipoint injection – Gasoline Direct Injection.

Combustion is SI engine: Stages of combustion –Ignition Lag-Flame propagation- Normal and Abnormal combustion- Detonation or knock-Factors affecting knock - Combustion Chambers types and designs.

UNIT -2: **[12 hrs]**

Properties of Fuel: Fuel sprays behavior - spray structure - spray penetration and evaporation – Air motion - Turbo charging – Supercharging, objectives, super charging of CI Engine -Cooling and Lubrication Systems.

Compression Ignition Engines: States of combustion in C.I. Engine - Diesel knock methods of controlling diesel knock- Direct and indirect injection systems – Combustion chambers type and design.

UNIT -3: **[12 hrs]**

Engine emissions and their control: Pollutant - Sources and types - formation of NOx - Hydrocarbon Emission Mechanism - Carbon Monoxide Formation - Particulate emissions - Methods of controlling Emissions- Catalytic converters and Particulate Traps-Selective Catalytic Reduction(SCR)-Diesel Oxidation Catalyst(DOC)-Methods of measurements – Emission Norms and Driving cycles. Diesel smoke and its control- Diesel odour and its control.

UNIT -4: **[12 hrs]**

Alternate Fuels and Recent trends in IC engines: Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas – Biodiesel- Biogas- Properties - Suitability - Engine Modifications - Merits and Demerits as fuels.

Recent trends in IC engines: LHR Engines-Learn Burn Engines Stratified charge spark ignition engine – Homogeneous charge compression Ignition- Plasma Ignition – Electric/Hybrid Vehicles-Electronic Engine Management.

Text books

1 R.B.Mathur and R.P.Sharma, (2002), Internal Combustion Engines., Dhanpat Rai & Sons
2. Ganesan V. (1999), Internal Combustion Engines, Tata McGraw Hill.

Reference books

1. Colin R.Feriguson, and Allan.T.Kirkpatrik, (2000), I.C.engines Applied Thermo sciences
2. John B. Heywood, (2000), Internal Combustion Engine Fundamentals, McGraw Hill.
3. Rowland S.Benson and N.D.White house, (2000) Internal combustion Engines, Vol. I and II, Pergamon Press.
4. Richard.L.Bechfold, Alternative Fuels Guide Book, SAE International Warrendale,1997.

5. "Alcohols as motor fuels progress in technology" - Series No.19 - SAE Publication

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5620	**PROCESSING OF MATERIALS IN MANUFACTURING**	16	HC	3	0	0	3	3
Prerequisites: Material Science		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To provide students with fundamental concepts of material processing in engineering
2. To introduce them to metal casting processes and composite reinforcement

Course Outcome:

After the completion of the course Student will be able to

1. Understand advanced manufacturing processes
2. Possess the knowledge of fibre reinforcement and techniques

Course Content:

UNIT -1: **[12 hrs]**

Introduction to the course and design projects, Intro. To CAD/CAM, engineering materials. Rapid prototyping; Stereolithography (STL), 3D ink jet printing, Fused-Deposition Method (FDM), Manufacturing polymers (plastics).

UNIT - 2: **[12 hrs]**

Manufacturing Processes Classifications, Mechanical properties of material and most commonly materials used. Design for Manufacture and Assembly, Introduction to Computer Numerical Control (CNC), Controllers, tool path, part programming. CNC – Electrical - Discharge Machining (EDM), CNC – Laser and water jet machining.

UNIT -3: **[12 hrs]**

Metal-Casting processes; Expendable mold, Permanent mold, Design consideration for casting, Bulk deformation process – Forging, Bulk deformation process – Rolling, Bulk deformation process– Extrusion, wire drawing, Sheet metal forming – Design considerations, Powder Metallurgy, design considerations

UNIT -4: **[12 hrs]**

Composites; reinforcement fibers, matrix material, Machining processes, Fabrication techniques for composites, powder metallurgy, stir casting, Injection molding, Filament winding, Pultrusion.

Textbooks:

1. Kalpakjian, S., and Schmid, S.R., Manufacturing Processes for Engineering Materials, 5th

edition, Prentice Hall Publishers, 2008
2. George E. Dieter, Mechanical Metallurgy.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5630	**STATISTICAL QUALITY CONTROL**	16	HC	3	0	0	3	3
Prerequisites: Basic Mathematics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Introduce the concept of SQC
2. Understand process control and acceptance sampling procedure and their application.
3. Learn the concept of reliability

Course Outcome:

After the completion of the course the students will be able to:

1. Understand the attributes in process control.
2. Appreciate the role of sampling procedure.
3. Understand the system reliability.

Course Content:

UNIT -1 Introduction and Process Control for Variables [12 hrs]

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality cost-Variation in process- factors – process capability – process capability studies and simple problems – Theory of control chart- uses of control chart – Control chart for variables – X chart, R chart and σ chart.

UNIT -2 Process Control for Attributes [12 hrs]

Control chart for attributes –control chart for proportion or fraction defectives – p chart and np chart – control chart for defects – C and U charts, State of control and process out of control identification in charts.

UNIT -3 Acceptance Sampling: [12 hrs]

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 Life Testing – Reliability [12 hrs]

Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series, parallel and mixed configuration – simple

problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.
Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.

Use of software tool for data analysis-hand's on.

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.

References:

1. Monohar Mahajan, Statistical Quality Control, Dhanpat Rai & Sons, 2001.
2. R.C.Gupta, Statistical Quality control, Khanna Publishers,6th Edition , 2003.
3. Besterfield D.H., Quality Control, Prentice Hall, 1993.
4. Sharma S.C., Inspection Quality Control and Reliability, Khanna Publishers, 2002.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5640	**POWER PLANT ENGINEERING**	16	HC	3	0	0	3	3
Prerequisites: Basic concept on Energy sources		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To exposure various methods of power generation using various resources.
2. To understand working principle and components used in power generation.
3. To know benefits and limitations of various types of power plants.
4. To know parameters to be considered for starting the power plant.

Course Outcome:

After completion of the course the student will be able to

1. Explain the working principle of the power plant.
2. Define the necessity of particular method of power generation.
3. Judge the suitable power plant for suitable place.
4. Identify the components and its application.

Course Content:

UNIT – 1 **[12 hrs]**

Steam Power Plant: Different types of fuels used for steam generation, Equipment for burning coal

in lump form, stokers, different types, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace.

Coal, Ash Handling and Different Types of Boilers : Coal and Ash handling, Generation of steam using forced circulation, high and supercritical pressures.

UNIT – 2 **[12 hrs]**

Chimneys, A brief account of La Mount, Benson, Velox, Schmidt, Loeffer and Ramson steam generators. **Cooling Towers And Ponds:** Natural, forced, induced and balanced draft. Accessories for The Steam Generator such as super-heaters, de-super heater, Economizers, Air Pre-heaters Study of different types of cooling towers and ponds.

Diesel Engine Power Plant: Method of starting diesel engines, Cooling and lubrication system for the diesel engine. Filters, centrifuges, Oil heaters, Intake and exhaust system, Layout of a diesel power plant .

UNIT -3 **[12 hrs]**

Hydro-Electric Plants: Storage and pondage, flow duration and mass curves, hydrographs, Low, medium and high head plants, pumped storage plants, Penstock, water hammer, surge tanks, gates and valves, power house, general layout. A brief description of some of the important Hydel Installations in India., Numerical

Nuclear Power Plant: Principles of release of nuclear energy Fusion and fission reactions. Nuclear fuels used in the reactors. Elements of the Nuclear reactor, Moderator, control rod, fuel rods, coolants. Brief description of reactors of the following types - Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Radio active waste disposal.

UNIT – 4 **[12 hrs]**

Choice of site for power station, load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor, Effect of variable load on power plant, selection of the number and size of units.

Economic Analysis of power plant: Cost of energy production, selection of plant and generating equipment, performance and operating characteristics of power plants, tariffs for electrical energy.

Text Books:

1. **Power Plant Engineering**, P.K Nag, 3rd Ed. Tata McGraw Hill2nded 2001,
2. **Power Plant Engineering.** Morse F.T., Van Nstrand.1998

Reference books:

1. **Water Power Engg**., Edition 3, Barrows, TMH, New Delhi. 1998
2. **Plant Engg. Hand Book**, Stanier, McGraw Hill. 1998
3. **Hydraulic Machines**, Jagadish Lal, Metropollitan Co 1996.
4. **Principles of Energy Conversion**, A.W. Culp Jr., McGraw Hill. 1996
5. **Power Plant Technology**, M.M. EL-Wakil, McGraw Hill, International. 1994
6. **Power Station Engg. Economics**, Skrotizke and V opat. 1994
7. **Power Plant Engineering,** Domakundawar, Dhanpath Raisons.2003

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5700A	**FLUID MACHINERY LAB**	16	HC	0	0	2	2	3
Prerequisites: Fluid Mechanics		Internal Assessment			Semester End Exam			
		20 Marks			30 Marks			

Course Objectives:

1. To provide practical knowledge in verification of principles of fluid flow
2. To impart knowledge in measuring pressure, discharge and velocity of fluid flow
3. To understand major and minor losses.
4. To gain knowledge in performance testing of hydraulic pumps and turbines

Course Out comes:

After completion of the course the student will be able to

1. Define fluid flow principles.
2. Analyze the performance of the fluid machineries.
3. Measure the quantity of flow or discharge
4. Calculate efficiency of the fluid flow devices

Course Content:

PART-A

(Individual Experiments)

1. Determination of coefficient of friction of flow in a pipe.
2. Determination of minor losses in flow through pipes.
3. Determination of force developed by impact of jets on vanes.
4. Calibration of flow measuring devices:
    a. Orifice plate meter b. Nozzle c. Venturi meter d. V-notch

PART-B

(Group Experiments)

1. Performance testing of Turbines
    a. Pelton Wheel b. Francis Turbine c. Kaplan Turbine
2. Performance testing of Pumps
    a. Single stage/Multistage Centrifugal pumps b. Reciprocating pumps
3. Performance test of a two stage Reciprocating Air Compressor.
4. Performance test on an Air Blower.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5700B	**COMPUTER AIDED MODELING AND ANALYSIS LABORATORY**	16	HC	0	0	2	2	3

Prerequisites: FEM, SOM	Internal Assessment	Semester End Exam
	20 Marks	30 Marks

Course Objectives:

1. To provide sound knowledge of stress, displacement, deformation and load distribution of the beam.
2. To familiarize with the stress concentration factor.
3. To provide capability to analyze and solve practical problems based on the concept of principle of super position.
4. To analyze complex trusses problems & its application in the real world scenario.
5. Carryout dynamic analysis of complex problems.
6. Conduct experiments related to Fixed – fixed beam for natural frequency determination.
7. To carryout thermal analysis in order to determine the heat flux and temperature distribution of the domain.
8. To analyze theoretically by using mathematical equations.

Course Outcomes:

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

1. Understanding of the basic concept of stress, displacement, deformation and load distribution of the beam.
2. Capability to analyze effect of stress concentration factor.
3. Capability to analyze and solve practical problems of concept of stepped & tapered bar.
4. Capability to analyze complex trusses problems.
5. Capability to analyze and provide solutions for the dynamic problems associated with various conditions.
6. Familiarization with the experimental methodology and ability to solve problems of fixed beam for natural frequency determination.

PART – A

Study of a FEA package and modeling stress analysis of

a. Bars of constant cross section area, tapered cross section area and stepped bar (Minimum 6 Exercises)

b. Trusses –(Minimum 2 exercises)

c. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises)

PART – B

a. Stress analysis of a rectangular plate with a circular hole

b. Thermal Analysis – 1D & 2D problem with conduction and convection boundary Conditions (Minimum 4 exercises)
c. Dynamic Analysis
   - Fixed – fixed beam for natural frequency determination
   - Bar subjected to forcing function
   - Fixed – fixed beam subjected to forcing function

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5800A	**ENERGY CONVERSION LAB**	16	HC	0	0	2	2	3

Prerequisites: Applied Thermodynamics	Internal Assessment	Semester End Exam
	20 Marks	30 Marks

Course Objectives:

1. To study the properties of the lubricants and fuels.
2. To know the performance of the engines.
3. To study the performance of the engines under various loading conditions.
4. To calculate various engine parameters.

Course Out comes:

After completion of the course the student will be able to
1. Identify various types of engines.
2. Define various engine parameters.
3. Analyze the engine for different loading conditions.
4. Compare the engines and select the engine on the basis of the performance

Course Content:

PART – A

1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's closed) / Cleavland's (Open Cup) Apparatus.

2. Determination of Calorific value of solid, liquid and gaseous fuels.

3. Determination of Viscosity of a lubricating oil using Redwood, Saybolt and Torsion Viscometers.

4. Valve Timing/port opening diagram of an I.C. engine (4 stroke/2 stroke).

5. Use of Planimeter

PART - B

1. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio and heat balance sheet for
   (a) Four stroke Diesel Engine
   (b) Four stroke Petrol Engine

(c) Multi Cylinder Diesel/Petrol Engine, (Morse test)
(d) Two stroke Petrol Engine
(e) Variable Compression Ratio I.C. Engine.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F5800B	**HEAT & MASS TRANSFER LAB**	16	HC	0	0	2	2	3

Prerequisites: Basic concept on Heat transfer and Fluid Mechanics	Internal Assessment	Semester End Exam
	20 Marks	30 Marks

Course Objectives:

1. To conduct the experiments to know modes of heat transfer and to find rate of heat transfer.
2. To find the heat transfer coefficient of air under natural and forced convection mode.
3. To know the use of fins and their performance.
4. To know the performance of various heat transfer devices.
5. To study the performance of the refrigerator and air conditioner.

Course Outcomes:

After completion of the course the student will be able to

1. Define the various modes of heat transfer.
2. Conduct the experiments to know the thermal properties of the materials.
3. Judge the mode of heat transfer which is effective for a particular application.
4. Determine the amount of heat transfer in a particular medium.

Course Content:

PART – A

1. Determination of Thermal Conductivity of a Metal Rod.
2. Determination of Overall Heat Transfer Coefficient of a Composite wall.
3. Determination of Effectiveness on a Metallic fin.
4. Determination of Heat Transfer Coefficient in a free Convection on a vertical tube.
5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
6. Determination of Emissivity of a Surface.

PART – B

1. Determination of Steffen Boltzmann Constant.
2. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers
3. Experiments on Boiling of Liquid and Condensation of Vapour
4. Experiment on Transient Conduction Heat Transfer
5. Performance study of Vapour compression refrigerator test rig
6. Performance study of Vapour compression Air-conditioner test rig

SIXTH SEMESTER

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6100A	**TURBOMACHINERY**	16	HC	3	1	0	4	5
Prerequisites: Fluid Mechanics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To provide a sound understanding of the comparison of positive displacement machine and Turbo machine.
2. To provide knowledge about impact of jet on vanes.
3. To provide an understanding of energy transfer in turbo machinery.
4. To provide knowledge about general analysis of radial flow turbo machines.
5. To provide knowledge about general analysis of axial flow turbo machines.
6. To provide knowledge of design of hydraulic turbines and its characteristics.
7. To provide knowledge about design of centrifugal pumps
8. To provide knowledge of flow through nozzles.
9. To provide knowledge of design of steam turbines.

Course Outcome:

After completion of the course the student will be able to

1. Differentiate positive displacement machines and turbo machines.
2. Explain of Euler turbine equation and velocity triangles.
3. Draw velocity triangles of axial flow turbines and compressors.
4. Analyze hydraulic turbines and centrifugal pumps.
5. Conduct performance test on various types of hydraulic turbines and pumps.

Course Content:

UNIT -1: **[12 hrs]**

Introduction: 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. Illustrative examples.

Impact of jets: Introduction, Force exerted by the jet on a stationary vertical plate, symmetrical and unsymmetrical curved vane at centre and tangentially at one of the tip. Force exerted by the jet on a moving vertical plate, force exerted by jet of water on unsymmetrical moving curved vane when jet strikes at centre and tangentially at one of the tips. Force exerted by a jet of water on series of plate (condition for maximum efficiency). Illustrative examples.

UNIT -2: Energy Transfer in Turbo Machine: **[12 hrs]**

Euler Turbine equation; Alternate form of Euler turbine equation – components of energy transfer; Degree of reaction, Utilization factor, Vane efficiency; Relation between utilization factor and degree

of reaction; Velocity triangles for different values of degree of reaction for axial flow turbines, Velocity triangles and condition for maximum utilization factor – optimum blade speed ratio for different types of turbine. Comparison of Energy transfer, Illustrative examples.

General analysis of Power absorbing turbo machines– General analysis of axial flow Compressors and pumps , velocity triangles and general expression for degree of reaction, 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. Illustrative examples.

UNIT -3: Hydraulic Turbines: **[12 hrs]**

Classification; Different efficiencies; Pelton Turbine-velocity triangles, condition for maximum efficiency, Design parameters; Francis turbine-velocity triangles, Design parameters; Function of a Draft tube, types of draft tubes; Kaplan and Propeller turbines – Velocity triangles and Design parameters. Illustrative examples.

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel, Illustrative examples.

UNIT-4: **[12 hrs]**

Steam Nozzles: Type of Nozzles- Flow Through Nozzles- Condition for Maximum Discharge- Nozzle Efficiency- Super Saturated Flow in Nozzles- Relationship Between Area Velocity and Pressure in Nozzle Flow. Illustrative examples.

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Reaction turbine – Parsons's turbine, condition for maximum utilization factor. Illustrative examples.

Text Books:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008.
2. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002

Reference Books:

1. Principals of Turbomachines, D. G. Shepherd, The Macmillan Company (1964).
2. Fluid Mechanics & Thermodynamics of Turbomachines, S. L. Dixon, Elsevier (2005).
3. Turbomachine, B.K.Venkanna PHI, New Delhi 2009.
4. Text Book of Turbomachines, M. S. Govindgouda and A. M. Nagaraj, M. M. Publications, 4Th Ed, 2008.
5. Thermal Engineering, by R.K.Rajput., Laxmi Publications

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6100B	**FINITE ELEMENT METHOD**	16	HC	3	1	0	4	5
Prerequisites: Mathematics, Numerical Methods, SOM		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To enable the students understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics, heat transfer and fluid flow problems.
2. Provide systematic and comprehensive knowledge of basics of Finite element method as an analysis tool.
3. To teach the students the characteristics of various elements and selection of suitable elements for the problems being solved.
4. To make the students derive finite element equations for simple and complex elements.

Course Outcome:

After completion of the course the student will be able to

1. Understand the different types of analysis methods
2. Analyze the bar and beam problems by Euler-Lagrange equations
3. Understand principle of minimum potential energy
4. Analyze the bar problems using elimination and penalty approach
5. Apply Lagranage's equation for Higher order elements
6. Solve truss problems using elimination approach
7. Derive Hermite Shape function and apply it to solve beam problems
8. Apply FEM method to solve 1D heat transfer problems

Course Outcome:

UNIT – 1 **[12 hrs]**

Introduction: Introduction to finite difference method and finite elements method, Advantages and limitations, Mathematical formulation of FEM, Steps involved in FEM, Different approaches in Finite Element Method - Direct Stiffness approach, simple examples, Variational approach, Elements of variational calculus -Euler Lagrange equation, Rayliegh Ritz method, Weighted Residual methods, Galarkin method.

UNIT – 2 **[12 hrs]**

Interpolation Models: Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular element.

Solution of 1-D Bars: Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique.

UNIT –3 **[12 hrs]** **Higher**

Order Elements: Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric

element Iso parametric, Sub parametric and Super parametric elements. Numerical integration : 1 and 2 gauge point for 1D case.

Trusses: Stiffness matrix of Truss element. Numerical problems

UNIT – 4 **[12 hrs]** **Beams:**

Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads.

Heat Transfer: Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction. Galerkin's approach for heat conduction.

Text Books:

1. **Finite Elements in Engineering**, T.R.Chandrupatla, A.D Belegunde, 3rd Ed PHI.
2. **Finite Element Analysis**, S.S. Bhavikatti, New Age International publishers,2006

Reference Books:

1. **"Finite Element Methods for Engineers"** U.S. Dixit, Cengage Learning, 2009
2. **Concepts and applications of Finite Element Analysis**, R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, Wiley 4th Ed, 2009
3. **Finite Element Methods**, Daryl. L. Logon, Thomson Learning 3rd edition, 2001.
4. **Finite Element Method**, J.N.Reddy, McGraw -Hill International Edition.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6200A	**THEORY OF MACHINES-II**	16	HC	3	1	0	4	5
Prerequisites: Theory of Machine-I, Engineering Mechanics, Strength of Materials		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To understand the synthesis and analysis of common mechanisms and concepts of turning moment diagrams, flywheel design
2. To understand the dynamics of engines, balancing of rotating and reciprocating masses, rotors and engines.
3. To study and realizations of speed control devices and their characteristics
4. To understand the working of mechanisms based on friction and its application
5. To develop the techniques of complete anatomy of all machineries

Course Outcome:

After completion of the course Student will be able to

1. Perform dynamic analysis of mechanisms like slider crank mechanism, four bar mechanism, IC engine and steam engine.
2. Do balancing of masses in rotation as well as reciprocating masses, rotors and engines.
3. Analyze and design of different types of governors and calculate gyroscopic couple.
4. Calculate frictional torque in different bearings, brakes and dynamometers and analyze belt

drives.

5. Formulate the dynamic analysis of various machines like IC engine, steam engine, governors, gyroscopes, rotating masses, dynamometers.

Course Content

UNIT -1 **[12hrs]**

Static & Dynamic Force Analysis : Static equilibrium of two/three force members, Static equilibrium of member with two forces and torque, Static force analysis of linkages, D'Alembert's principle, Equivalent offset inertia force, Dynamic force analysis of four link mechanism and slider crank mechanism, Engine force analysis- Piston and crank effort

Turning Moment & Flywheel: Turning moment on crankshaft, Turning moment diagrams-single cylinder double acting steam engine, four stroke IC engine and multi-cylinder steam engine, Fluctuation of energy, Design of Flywheel.

UNIT -2: **[12 hrs]**

Balancing of Machines: Balancing of Rotating Masses: Static and dynamic balancing, Balancing of several masses in the same plane and different planes,

Balancing of Reciprocating Masses: Balancing of primary force in reciprocating engine, Partial balancing of two cylinder locomotives, inline and V-engine, Swaying couple, hammer blow. Numerical

UNIT -3: **[12 hrs]**

Governors: Introduction, Principles, Types of governors, Terminology, Porter & Hartnell governor, Sensitivity, Stability, Hunting, Isochronism, Effort and Power of governor, controlling force diagrams. Numerical.

UNIT -4: **[12 hrs]**

Gyroscopic Motion: Principles, Gyroscopic torque, Effect of gyroscopic couple on the stability of aero planes, ship & automobiles (two & four wheelers).

Text books:

1. **Theory of Machines** - Thomas Bevan,3rd edition,CBS publications.
2. **Theory of Machines and Mechanisms**- Shigley, 3rd edition Mc Graw Hill Book company
3. **Theory of Machines** – R S Khurmi & J K Gupta, 5th edition, S. Chand publications
4. **Theory of Machines** – R. K. Bansal , 6th edition, Laxmi Publications

Reference books:

1. **Theory of Machines and Mechanisms**-Ghosh & Mallik 3rdedition, East west press
2. **Theory of Machines**-S.S. Rattan, 3rd edition, 2013,TMH publications
3. **Kinematics of Machines**-Dr. Sadhu Singh, 2nd edition, Pearson Publication

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6200B	**HEAT AND MASS TRANSFER**	16	HC	3	1	0	4	5
Prerequisites: Thermodynamics & Fluid Mechanics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Provide sound understanding of the basic principles and laws governing the heat and mass transfer.
2. To familiarize with the various modes of heat transfer, combined heat transfer processes and special heat transfer processes.
3. To provide capability to analyze and solve practical problems from basic principles and provide numerical solutions.
4. To analyze complex heat transfer problems and provide solutions using heat transfer data hand book.
5. Carryout analysis of boiling and condensation phenomenon and design heat transfer equipments.
6. Conduct experiments related to various heat transfer processes and heat exchangers and analyze measurement data.

Course Outcome:

After completion of this course the students will be able to

1. Understanding of the basic principles and laws governing the heat and mass transfer.
2. Knowledge of the various modes of heat transfer, combined heat transfer processes and special heat transfer processes and its application.
3. Capability to analyze and solve practical problems from basic principles and provide numerical solutions.
4. Capability to analyze complex heat transfer problems and provide solutions using heat transfer data hand book.
5. Capability to analyze and provide solutions for the design of heat transfer equipment.
6. Familiarization with the experimental methodology and ability to solve problems.

Course Content

UNIT -1: **[12 hrs]**

Introduction: Modes of Heat Transfer, Basic Laws of Heat Transfer, Overall Heat Transfer Coefficient, thermal contact resistance, Boundary Conditions, 3-D Conduction Equation in Cartesian Coordinates, Discussion On 3-D Conduction Equation in Cylindrical and Spherical Coordinate Systems (No Derivation). 1-D steady state heat conduction without heat generation through plane slabs, cylinders and spheres with uniform thermal conductivity (no derivation). Heat transfer through composite wall, cylinder and sphere and applications, contact thermal resistance. Numerical examples.

critical thickness of insulation without heat generation. Theory of Fins-Types of fins, Governing equations for different conditions of fins(no derivations), Fin effectiveness and fin efficiency, Numerical examples.

One –Dimensional Transient Conduction: Lumped parameter Analysis, Use of Heisler's Charts for transient conduction in plane slab, long cylinder and sphere. Numerical examples.

UNIT -2: **[12 hrs]**

Concepts and basic relations in boundary layers: Hydrodynamic and thermal boundary layers over flat plate, critical Reynolds number, local heat transfer coefficient, average heat transfer coefficient, Flow inside a duct, hydrodynamic and thermal entrance lengths.

Natural or Free convection: Application of dimensional analysis for free convection –physical significance of Grasshoff number, use of correlations in free convection for horizontal, vertical flat plates, cylinders and spheres. Numerical examples.

Forced convection heat transfer: Application of dimensional analysis for forced convection problems. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of correlations for hydro-dynamically and thermally developed flows in case of a flow over a flat plate, a cylinder and sphere. Numerical examples.

UNIT -3: **[12 hrs]**

Radiation Heat Transfer: Thermal radiation; definitions of various terms used in radiation heat transfer; Stefan-Boltzman law, Kirchhoff's law, Planck's law and Wien's displacement law. Radiation heat exchange between two parallel infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle; Lambert's law; radiation heat exchange between two finite surfaces configuration factor or view factor. Numerical problems.

Mass transfer: Definition and terms used in mass transfer analysis, Fick's First law of diffusion , (no numerical).

UNIT -4: **[12 hrs]**

Heat Exchangers: Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical examples.

Condensation And Boiling: Types of condensation (discussion only) Nusselt's theory for laminar condensation on a vertical flat surface(no derivations) use of correlations for condensation on vertical flat surfaces, horizontal tube and horizontal tube banks; Reynolds number for condensate flow; regimes of pool boiling, pool boiling correlations. Numerical examples.

Text Books:

1. **Heat & Mass transfer**, Tirumaleshwar, Pearson education 2006
2. **Heat transfer-A basic approach**, Ozisik, Tata McGraw Hill 2002

Reference Books:

1. **Heat transfer, a practical approach**, Yunus A- Cengel Tata Mc Graw Hill
2. **Principles of heat transfer**, Kreith Thomas Learning 2001
3. **Fundamentals of heat and mass transfer,** Frenk P. Incropera and David P. Dewitt, John Wiley and son's.
4. **Heat transfer**, P.K. Nag, Tata McGraw Hill 2002.
5. **Heat and Mass Transfer**, Mahesh M Rathore, Laxmi publications.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6300	**CAD/CAM/CIM**	16	HC	3	0	0	3	3
Prerequisites: Manufacturing Technology		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To learn the fundamentals of CAD/ CAM / CIM and related concepts to understand the various modeling features and its manufacturing.
2. To understand how by integrating 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. To understand the concept of programming and its importance in practical applications in order have an edge cut manufacturing aspects.
4. To have a hands on experience on various tools used for modeling and manufacturing aspects.
5. To study about the programming aspects by using machine code languages for various operations using sophisticated software's (Manual and computer aided part programming)

Course Outcomes:

After completion of the course the student will be able to

1. Students can able to analyze the basic principles of CAD & CAM in engineering applications.
2. Application of Computers in manufacturing aspects.
3. Geometrical modeling of an component by using Software
4. Generation of part programming by using machine language codes.
5. This subject is an prerequisite for an analysis, which will be helpful for project work..
6. Reduction of Manufacturing Lead time and Product development time.

Course Content

UNIT - 1 **[12 hrs]**

Fundamentals of CAD: Definition of CAD/CAM, Product cycle and its cad / cam overlaid, Design process & application of computers for design, creating the manufacturing database, Benefits and achievement of CAD. Hardware in CAD: Basic Structure, CPU, Memory Types, Input Devices, Display Devices, Hard Copy Devices, Storage Devices, Software.

Computer Graphics: Raster Scan Graphics, Coordinate Systems, Database Structure for Graphic Modeling, functions of graphics package, Transformation of geometry, 2D transformations – Simple

problems. Geometric Modeling: Requirements for geometric modeling, Geometric Models, Geometric Based Modeling, Constrain Based Modeling, Curve Representation, Surface Representation methods. Windowing and clipping.

UNIT -2 **[12 hrs]**

Introduction to NC Technology: Basic components of NC system, Where NC is most appropriate, NC Coordinate system, types of NC motion control systems, advantages and applications of NC, influence of computers in manufacturing environment. CNC & DNC Systems: Types, advantages and its functions. Adaptive control systems, types of CNC turning centers and machining centers.

NC/CNC Programming: NC Procedure, Programming: Manual and adaptive part programming, Block formats in part programming, G & M codes, Cutter Radius Offset, Tool Length Offset, Fixed Cycles/canned cycles, Turing programs, Drilling and milling programs.

UNIT -3 **[12 hrs]**

Computer integrated Manufacturing System: Introduction, Automation definition, Types of Automation, CIM processing in Manufacturing, Types of Production, Production Concepts & its Mathematical models, Problems on mathematical model equations, Automation Strategies, CIM information processing cycle, Costs of Manufacturing operations.

High Volume Production system: Introduction, Automated flow line, Work part transport, Transfer Mechanism, Buffer storage and its control functions, Automation for machining operations.

Computerized Manufacturing planning system: Computer aided process planning and MRP

UNIT -4 **[12 hrs]**

Analysis of Automated Flow line: General terminology and analysis, Analysis of Transfer line with and without storage with numerical problems, Partial automation with numerical problems, Flow lines with more than two stages-numerical.

Assembly and Line balancing: Manual Assembly lines, Types of automated assembly system, Parts feeding devices. Minimum rational work element, cycle time. Precedence constraints and diagram, Balance delay. Methods of Line balancing – Largest candidate rule, Kilbridge and Westers method, RPW method and numerical problems covering above methods and computerized line balancing.

Text Books:

1. **CAD/CAM, Computer Aided Design and Manufacturing**, M.P.Groover & Emory W.Zimmer, Pearson India, 2007 2nd edition.
2. **Automation, Production system & Computer Integrated Manufacturing**, Mikell P.Groover, Pearson India, 2007 2nd edition.

Reference Books:

1. **CAD/CAM theory and practice** by Ibrahim Zeid, Tata McGraw hill.
2. **CAD/CAM/CIM** by P. RadhaKrishnan, S. Subramanyan & V. Raju, New Age international Publishers , 2nd edition.
3. **Computer Numerical Control Machines and CAM** by P. RadhaKrishnan, New Age international Publishers, 1st edition 2012.
4. **CAD/CAM Principles and applications** by P. N. Rao, Tata McGraw hill.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6400	**MACHINE DESIGN – II**	16	HC	3	1	0	4	5
Prerequisites: Material Science, SOM		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To carry out the design of curved beams used in Crane hook, punching presses, clamps, closed rings and links and flexible machine elements like belts, chains, ropes.
2. To experience the design of gears such as spur, helical, bevel and worm gears.
3. To know the design of various types of springs and Bearings.
4. To carry out the design of clutches, brakes used in automotives and I.C.Engine parts like piston, connecting rod.

Course Outcome

After completion of the course the student will be able to

1. Clear understanding of the design of curved beams, belts, chains, ropes.
2. Knowledge about the detailed design of various gears such as spur, helical, bevel and worm gears.
3. Detailed procedure of the design processes of machine members like springs, bearings, clutches, brakes, and I.C.Engine parts like piston, connecting rod.

Course Content:

UNIT- 1 **[12 hrs]**

Curved Beams: Stresses in curved beams of standard cross sections. used in crane hook, punching presses & clamps, closed rings and links.

Design of Belt, ropes and chain drives: Belt Drives, design of flat belts, Selection of V- belts, Rope drives-selection of wire ropes, Chain drives- Roller chains, design & selection of roller Chain drives.

UNIT- 2 **[12 hrs]**

Springs: Types of springs - Energy stored in springs, stresses in Helical coil springs of circular and non-circular cross sections. Tension and compression springs, Springs under fluctuating loads, Leaf Springs: Stresses in leaf springs. Equalized stresses, Belleville springs.

Clutches & Brakes: Design of Clutches: Single plate, multi plate and cone clutches. Design of Brakes: Block and Band brakes, self locking of brakes, Heat generation in Brakes.

UNIT- 3 Design of Gears **[12 hrs]**

Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load.

Helical Gears: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads.

UNIT-4 **[12 hrs]**

Bevel Gears: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads.

Worm Gears: Definitions, Design based on strength, dynamic, wear loads and efficiency of worm gear drives.

Text Books:

1. **Design of Machine Elements**, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. **Machine Design**, R.S. Khurmi & J.K.Gupta, S. Chand Publications.

Reference Books:

1. **Machine Design**, Dr.P.C.Sharma & Dr.D.K.Aggarwal,S.K.Kataria and Sons, New Delhi.
2. **Mechanical Engineering Design**, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2009.

Design Data Handbook:

1. **Design Data Hand Book**, K. Lingaiah, McGraw Hill, 2nd Ed.
2. **Data Hand Book**, K. Mahadevan and Balaveera Reddy, CBSPublication
3. **Design Data Hand Book**, H.G. Patil, I. K. International Publisher,2010.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6510	**REFRIGERATION AND AIR-CONDITIONING**	16	SC	3	0	0	3	3
Prerequisites: Basic and Applied Thermodynamics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To enable the students to understand the principles of refrigeration and air conditioning
2. To teach the students how to calculate the cooling load for different applications of Refrigeration and Air-conditioning

3. To expose the students to cyclic controls and system balancing
4. To teach students the principles of psychrometry
5. To develop the knowledge of students in selecting the right equipment for a particular application of Refrigeration and Air-conditioning

Course Outcome:

After completion of the course the Student will be able to

1. Possess the knowledge of system components of refrigeration and air conditioning Design and implement refrigeration and air conditioning systems using standards
2. Apply the knowledge of psychrometry in calculating cooling load and heating load.
3. Able to calculate load and select the size of the components.

Course Content

UNIT -1 **[12 hrs]**

Refrigeration Cycles and System: Brief discussion about Vapour compression refrigeration cycles and actual vapour compression cycle(detail discussion) Air refrigeration cycles(In brief)-Aircraft refrigeration system- various types- numerical on aircraft refrigeration system. Multi stage compression –Multi evaporator system-cascade system-simple numerical. Vapour absorption systems-Lithium bromide, three fluid vapour absorption systems.

UNIT-2 **[12 hrs]**

Refrigerants and Refrigeration Components:- Refrigerant classification–primary and secondary refrigerants. Designation—Detail discussion about selection of refrigerants, CFC'S, HCFC's and HFC's. Global warming and Ozone depleting aspects. Alternate refrigerants, Refrigerant absorbent combinations for vapor absorption system, Refrigerant compressors, Reciprocating, Rotary type, Condensers, Evaporators, Expansion devices, Low side-high side float, low pressure and high pressure cut outs, solenoid valves.

UNIT -3 **[12 hrs]**

Psychrometry and Load Estimation:-Review of Moist air properties-various psychrometric process, psychrometric chart. Zoned, central, unitary system. Load estimation-comfort chart-SHF-GRSHF-ERSHF, cooling load estimate, heating load estimate, solar heat gain, infiltration, internal heat gain, Numerical on load estimation

UNIT -4 **[12 hrs]**

Air-conditioning Equipments:- Package unit, central unit. Air distribution system- principles- air handling system, ducts and its arrangements, filters, fans, room air distribution- supply air outlets.

Application of Refrigeration and Air-conditioning:- Food preservation-necessary-food freezing-various types, cold storage plants, Domestic refrigerator-construction and working and maintenance, Water coolers-storage type and pressure type, Dessert cooler, Window air conditioners, split air

conditioners-Discussion on one case study on design and installation of Centralized air conditioning system for Hospital/Hotel/commercial complex/Software company etc,.

Text Books

1. S. C. Arora and Dumkundwar, (1996), **Refrigeration and Air-Conditioning**, Dhanpathrai
1. Publishers
2. R K Rajput "**Refrigeration and Air conditioning**" second edition, S K kataria and sons

References

1. Manohar Prasad, (1998), **Refrigeration and Air conditioning**, Wiley Eastern Ltd.
2. Arora, C. P., (2007), **Refrigeration and Air Conditioning**, Tata McGraw-Hill Publishing Company Ltd.
3. W. F. Stocker and J. W. Jones, (2002), **Refrigeration and Air conditioning**, McGraw Hill.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6520	**MANUFACTURING TECHNOLOGY-III**	16	SC	3	0	0	3	3
Prerequisites: Manufacturing Technology –I and II		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. The course will enable the students to acquire a fundamental knowledge on metal forming technology which is necessary for an understanding of industrial processes.
2. To introduce students to the wide range of materials and processes, which are currently used in manufacturing industry.
3. The course will also provide methods of analysis allowing a mathematical/physical description of forming processes.
4. The course will enable the students to identify the processes characteristics, select the main operator parameters, the tool geometry and materials, and determine forces and power required to select the main and auxiliary equipment.

Course Outcomes:

After completion of the course the student will be able to

1. Understand necessity of forming process compared with other manufacturing techniques
2. Select the process for different materials
3. Identify the parameters which effects processing of the wrought products.
4. Select the process, load required and possible reasons for the formation defects of the forged components

5. Identify and analyze production of wire, rod , tubes using different processes and problems occurred in the process
6. Select the different process, related equipments, parameters for the fabrication of various sheet metal components
7. Select the different high energy rate forming process suitable for fabrication of bulk sheet metal components.

Course Contents:

UNIT -1: Introduction And Concepts: **[12 hrs]**

Classification of metal forming processes, Hot working and cold working , advantages and limitations of metal working processes. Concepts of true stress and true strain, Relationship between conventional and true strain, Stress system, Yield criteria, ,concepts of plane stress & plane strain, Numerical problems.

Variables in Metal forming: Temperature in metal forming, strain rate or Deformation velocity, Grain size and microstructure, Friction in metal forming, Lubrication in metal forming, Formability of materials, Deformation zone geometry, hydrostatic pressure, Residual stresses in metal working.

UNIT-2 **[12 hrs]** **Forging:**

Introduction. Forging operation, Classification of forging processes, Forging machines & equipment: power hammer and power presses. Grain flow in forging, Expressions for forging, pressure and loads. Forging die design parameters, Defects in forging, Residual stresses in forging. Simple problems.

Rolling: Introduction, Terminology of shapes produced in rolling, Classification of Rolling processes. Types of rolling mills, Forces and geometric relationship in rolling, Roll separating force, power required in rolling, Front and back tension in rolling, Maximum possible reduction in rolling, Rolling variables, Defects and numerical problems.

UNIT -3: **[12 hrs]**

Drawing: Rod drawing, wire drawing, Dies for drawing, Tube drawing, Expression for Drawing load by slab analysis, Defects in Drawn products. Redundant work and its estimation, optimal cone angle & dead zone formation, drawing variables, simple problems.

Extrusion: Introduction, Methods of extrusion, extrusion equipment & dies ,Extrusion process parameters and variables, Expression for extrusion force, Extrusion of seamless tubes, Deformation lubrication and defects in extrusion, simple problem.

UNIT-4: Sheet & Metal Forming **[12 hrs]**

Introduction, Sheet metal forming methods, Dies and punches, Rubber forming. Stretch forming, LDR in drawing, Forming limit criterion, defects in deep drawn products, piercing, blanking, bending, deep drawing, stretch forming, Die and punch design parameters in deep drawing, simple problems.

High Energy Rate Forming Methods and Powder Metallurgy: Introduction , Principles, advantages and applications, explosive forming, electro hydraulic forming, Electromagnetic forming. Basic steps in Powder metallurgy ,methods of production of metal powders, conditioning and blending powders, compaction and sintering, hot pressing, finishing and inspection, application of powder metallurgy components, advantages and limitations.

Text Books:

1. **Mechanical metallurgy (SI units),** G.E. Dieter, Mc Graw Hill pub.2001
2. **Manufacturing Process – III**, Dr. K.Radhakrishna, Sapna Book House, 2009.

Reference Books:

1. **Materials and Processes in Manufacturing**, E.paul, Degramo, J.T. Black, Ronald, A.K. Prentice -hall of India, 2002
2. **Principles of Industrial metal working process**, G.W. Rowe, CBSpub. 2002
3. **Manufacturing Science**, Amitabha Ghosh & A.K. Malik - East - Westpress 2001
4. **Technology of Metal Forming Process,** Surendra kumar, PHI –2008

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6530	**PRODUCTION PLANNING & CONTROL**	16	SC	3	0	0	3	3
Prerequisites: Manufacturing Technology –I and II		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Understand the process planning concepts
2. Prepare cost estimation for various products after process planning

Course Outcome:

After completion of the course the students will able to:

1. Understand the characteristics of different types of tools and techniques available and their applications.
2. Approach the process planning activities, selection of machine based on process requirement and develop the manufacturing logic.
3. Determine data required for Cost estimation and estimate the production cost for different jobs.

Course Content:

UNIT -01 Introduction to Process Planning, Process Control and Forecasting [12 hrs]

Definitions, Objectives of production Planning and Control, Functions of production planning and control, Elements of production control, Types of production, Organization of production planning and control department, Internal organization of department, Product design factors, Process Planning sheet.

Forecasting – Importance of forecasting, Types of forecasting, their uses , General principles of forecasting, Forecasting techniques– qualitative methods and quantitive methods- Opinion and

Judgmental methods, Time Series methods, Exponential smoothing, Regression and Correlation methods (with numerical).

UNIT-02 Operations Decision Making, aggregate planning and master scheduling [12 hrs]

Introduction, Characteristics of decisions, framework for Decision Making, Decision methodology, Decision supports systems, Economic models, Statistical models with numerical**.**

Introduction, Planning and Scheduling, Objectives of Aggregate Planning, Aggregate Planning Methods, Master Scheduling Objectives, Master Scheduling Methods. (with numerical)

UNIT-03 Inventory Management, MRP and ERP: [12 hrs]

Definition and Need, Components Inventory, inventory control.Functions of inventories, relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P– Systems and Q-Systems. (with numerical)

Introduction to MRP & ERP, LOB (Line of Balance), JIT inventory, and Japanese concepts. System Parameters, MRP Logic, System refinements, Capacity Management, CRP activities. Concept of continuous improvement of process. (with numerical)

UNIT-04 Routing, Supply Chain Management and Dispatching [12 hrs]

Definition, Routing procedure, Route sheets, Bill of material, Factors affecting routing procedure.

Introduction to supply chain management- Approaches to purchase and supply chain management, make or buy decision, e-Procurement, Vender development, rating, and certification.

Activities of dispatcher, Dispatching procedure –follow up – definition -types of follow-up, applications of computer in production planning and control.

Text Books:

1. Samuel Eilon, **"Elements of Production Planning and Control",** 1st Edition, Universal Publishing Corp., 1999.

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. Joseph Monks, "**Operations Management Theory and Problems**", 3rd Edition, McGraw-Hills,1987.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6540	**THEORY OF ELASTICITY**	16	SC	3	0	0	3	3

Prerequisites: SOM	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1. To obtain the stress strain relation within the elastic body.
2. Thermal distribution occurring within the elastic body.
3. To find the principle stress and strain for a different types of elastic body.

Course Outcomes:

After completion of the course the student will be able to

1. Solve two and three dimensional problems of cylindrical bodies.
2. Know the stress strain relation for a body subjected to loading within elastic limit.
3. Got the relation for a body subjected to thermal expansion.

Course Content

UNIT – 1 **[12 hrs]**

Definition And Notation: Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions.

Strain At A Point: Compatibility Equations, Principal Strains, Generalised Hooke's law, Methods of Solution of Elasticity Problems – Plane Stress- Plane Strain Problems.

UNIT – 2 **[12 hrs]**

Two Dimensional Problems: Cartesian co-ordinates – Airy's stress functions – Investigation of Airy's Stress function for simple beam problems – Bending of a narrow cantilever beam of rectangular cross section under edge load – method of Fourier analysis – pin ended beam under uniform pressure.

General Equations In Cylindrical Co-Ordinates: Thick cylinder under uniform internal and / or external pressure, shrink and force fit, stress concentration.

UNIT – 3 **[12 hrs]**

Stresses In An Infinite Plate (with a circular hole) subjected to uniaxial and biaxial loads, stress concentration, stresses in rotating discs and cylinders.

Torsion Of Circular, Elliptical And Triangular Bars: membrane analogy, torsion of thin open sections and thin tubes.

UNIT – 4 **[12 hrs]**

Thermal Stresses: Thermo elastic stress strain relationship, Equations of equilibrium Thermal stresses in thin circular discs and in long circular cylinder, sphere.

Uniqueness Theorem: Principle of super position, reciprocal theorem, Saintvenant principle.

Text Books:

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill,2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972

Reference Books:

1. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
2. **Elasticity, Theory, Applications & Numericals,** Martin H Sadd, Elsevier. 2005
3. **Applied Elasticity,** Seetharamu & Govindaraju, Interline Publishing
4. **Applied Elasticity,** C.T. WANG Sc. D. McGraw Hill Book Co.1953

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6610	**RENEWABLE ENERGY RESOURCES**	16	SC	3	0	0	3	3
Prerequisites: Concept on Energy resources		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To provide students an overview of global energy resources.
2. To introduce students to bio-fuels, hydrogen energy and solar energy.
3. To enable the students understand the importance of energy efficiency and conservation in the context of future energy supply.
4. To expose students to future energy systems and energy use scenarios with a focus on promoting the use of renewable energy resources and technologies.

Course Outcome:

After completion of the course the student will be able to

1. Possess the knowledge of global energy resources.
2. Use the renewable technologies like solar, biomass, wind, hydrogen etc. to produce energy.
3. Involve in optimizing and selecting an alternate source of energy.

Course Content:

UNIT -1: Introduction **[12 hrs]**

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),calculation for sizing biogas plant.

UNIT -2: Hydrogen Energy: **[12 hrs]**

Introduction to hydrogen energy, methods of hydrogen production(electrolytic and thermo chemical method), hydrogen storage and transportation, safe burning of hydrogen.

UNIT -3: Solar Energy and applications: **[12 hrs]**

Solar radiation - Availability- Measurement and estimation- Solar radiation geometry-Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time, day length, simple numerical.

Introduction to solar collectors(liquid and air flat plate collectors-working principle with diagram), Thermal storage(Sensible and latent heat storage), Solar distillation- PV cell- solar furnace-solar green house-solar production of hydrogen-working principle with diagram.

UNIT -4: Ocean Thermal Energy and Geothermal energy Conversion: **[12 hrs]**

Geothermal energy- Availability - Geographical distribution - Power generation using OTEC - Wave and **Tidal energy** - Scope and economics - Limitations.

Wind Energy: Wind energy - General considerations - Wind Power plant design – Horizontal axis wind turbine - Vertical axis wind turbine - Rotor selection - Design considerations - Choice of power plant - Wind mapping and selection of location - Cost analysis and economics of systems utilizing renewable sources of energy.

Text Books

1. David Merick, Richard Marshall, (2001), **Energy, Present and Future Options, Vol. I and II**, John Wiley and sons.
2. **Non-Conventional Energy Sources** by *G.D Rai K*, Khanna Publishers, 2003.
3. **Solar energy,** by *Subhas P Sukhatme* – Tata McGraw Hill, 2nd Edition, 1996
4. **Power Plant Engineering**, Domakundawar, Dhanpath Rai sons. 2003
5. **Power Plant Engineering**, P. K. Nag Tata McGraw Hill 2nd edn 2001.

Reference books:

1. **Renewable Energy Sources and Conversion Technology** by N.K.Bansal, Manfred Kleeman & Mechael Meliss, Tata McGraw Hill, 2001.
2. **Solar Power Engineering,** P.K.Nag, Tata McGraw Hill, 2003.
3. **Renewable Energy Resources,** John.W.Twidell, Anthony. D. Weir, EC BG-2001.
4. **Non conventional Resources**, B H Khan TMH - 2007

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.

BTME16F6620	**MECHATRONICS & MICROPROCESSOR**	16	SC	3	0	0	3	3
Prerequisites: Basic Electronics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To understand elements of measurement systems and appreciate its relevance in engineering design
2. To impart knowledge about working & performance of widely used sensors and actuators, electrical actuation systems.
3. To gain knowledge of elements and programming techniques involved in microprocessors and microcontrollers which are essential to understand the emerging field of automation.

Course Outcomes

After completion of the course the student will be able to

1. Understand the elements of microprocessor based controller systems
2. Understand the working sensors and transducers
3. Understand the different types of actuation systems
4. Understand the basics, architecture and programming of microprocessor and microcontrollers

Course Content:

UNIT -1 **[12 hrs]**

Introduction: Measurement and control systems their elements and functions, Microprocessor based controllers, examples of mechatronic systems.

Transducers and Sensors: Static and dynamic characteristics of sensor, Potentiometers-LVDT-Capacitance sensor-Strain gauges-Eddy current sensor-Hall effect sensor-Temperature sensors-Light sensors.

UNIT -2 **[12 hrs]**

Actuation System: Electrical systems, Mechanical switches, solid-stat switches, solenoids, DC & AC motors, Stepper motors. Elements of mechanical actuation system . Introduction to programmable logic controllers.

UNIT -3 **[12 hrs]**

Introduction to microprocessors: Evolution of microprocessor, organization of microprocessor, basic concepts of programming of microprocessors. Boolean algebra, Logic gates & gate networks, Binary & Decimal number systems, memory representation of positive and negative integers,

maximum and minimum integers. Conversion of real numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation.

Logic functions: Data word representation, basic elements of control system, 8085A processor architecture, terminology-CPU, ALU, data registers, assembler, fetch cycle, bus, interrupts. Micro controllers and its classification, difference between microprocessors and microcontrollers.

UNIT -4 **[12 hrs]**

Organization and programming of Microprocessors: Introduction of INTEL 8085-Data and Address buses, Instruction set of 8085, programming the 8085, assembly language programming**.**

Central Processing Unit of Microprocessors: Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8085 and INTEL 4004 register organization

Text Books:

1. **Mechatronics,** W.Bolton fourth edition, Pearson Publications, 2008.
2. **Microprocessor Architecture, Programming and applications with 8085/8086A,** R.S Ganokar, Wiley Eastern.

Reference Books:

1. **Mechatronics System Design,** Devdas shetty and Richard A. Kolk.
2. **Microprocessors and Microcontrollers,** Krishna Kant, Prentice Hall of India, 2007.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6630	**INDUSTRIAL ENGINEERING**	16	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Fundamentals of Industrial Engineering, Application of Work study in the shop floor, Formulation of an LPP, Product Mix with respect to optimization.
2. To known the concepts of method study and work measurement with their relative technique.
3. To understand and learn the various application of industrial engineering techniques for the day to day process.
4. To determine the standard time for the specified job.

5. To know the various types of plant layout and its location in details.

Course Outcomes:

After completion of the course the students will be able

1. Apply the various techniques in order to analyze the production system with respects to industrial scenario.

Course Content:

UNIT -1: **[12 hrs]**

Introduction: Industrial Revolution and historic development of the factory system. Concept of Productivity, Various types of productivity, causes for lack of productivity and increase of work content. Production system and its types.

Plant location and layout: Factors influencing plant location, theories of plant location, location economics, selection of specific site. Plant layout: Objectives of plant layout, principles of plant layout, types of plant layout, their merits and demerits, line balancing, Evaluation of Layouts.

UNIT -2 **[12 hrs]**

Work study and its techniques: Definition of work study, Basic procedure of work study.

Method study: Introduction to method study, Definition, selection, recording, examining, developing, installing and maintaining new method. Use of recording techniques such as outline process , flow process chart, Two handed process chart, multiple activity chart, flow diagram , String diagram, Travel chart. Principles of motion economy, Micro motion study and simo chart.

Work Measurement: Definition, Common steps in work measurement, Time study method, breaking the task into work elements, types of elements, rating and different methods of rating. Allowances and its types. Calculation of basic time and standard time with numerical.

UNIT – 3 **[12 hrs]**

Work sampling: Principles, Procedure, confidence limits, number of observations required, advantages and disadvantages, applications. Ergonomics: Human factors in the design of workplace, layout of equipment, design of displays and controls. Fatigue and measurement of fatigue.

Material Handling: Principles of material handling, classification of material handling equipment, selection of material handling equipment in details

UNIT -4 **[12 hrs]**

Equipment Replacement: Nature of replacement problems, economic life of challenger and defender, Replacement of items – individual replacement and group replacement .

New forms of work organization.

Design of individual work roles, Design of group work in production, Design of product oriented organization, flow patterns in product oriented organizations, Criteria for good work organization.

Depreciation – Definition, factors, Types of Depreciation with numerical.

Text Books:

1. **Introduction to Work study**, ILO(International Labor organization)
2. **Industrial Engineering and Economy** , O.P.Khannan, PHI Publisher

Reference Books:

1. **Hand book of Industrial Engineering** , Maynard
2. **Motion and time study**, Ralph.M.Barnes, John wiley.
3. **Motion and time study** , Marvin.E.Mundel ,

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6640	**EXPERIMENTAL STRESS ANALYSIS**	16	SC	3	0	0	3	3
Prerequisites: Mechanics of materials, Design of Machine elements.		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To understand the relation between the mechanics theory and experimental stress analysis
2. To study the working principles of different types of strain gauges
3. To know the fundamentals of photo elastic coatings
4. To study the effects of 2-D photo elasticity
5. To be able to use the experimental techniques on the practical problems.

Course Outcomes:

After completion of the course the student will be able to

1. Demonstrate a basic understanding of experimental methods (e.g. strain gages, photo elasticity) commonly used in experimental solid mechanics.
2. Identify the different types of strain gauges
3. Apply the concepts of photo elastic coatings
4. Analyze the behavior of 2-D and 3-D photo elasticity

Course Content:

UNIT-1 **[12 hrs]**

Electrical Resistance Strain Gages: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics,

Environmental effects, Strain Gage circuits. Potentiometer, Wheatstone's bridges, Constant current circuits.

Strain Analysis Methods: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage.

UNIT -2 **[12 hrs]**

Photo-elasticity: Nature of light, Wave theory of light - optical interference , Stress optic law – effect of stressed model in plane and circular polariscopes, Isoclinics & Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photoelastic model materials**.**

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 **[12 hrs]**

Three Dimensional Photo elasticity: Stress freezing method, Scattered light photo-elasticity, 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 **[12 hrs]**

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 ,0ut of plane displacement measurements, Out of plane slope measurements .Applications and advantages

Text Books:

1. **"Experimental Stress Analysis",** Dally and Riley, McGraw Hill.
2. **"Experimental Stress Analysis".** Sadhu Singh, Khanna publisher.
3. **Experimental stress Analysis**, Srinath L.S tata McGraw Hill.

Reference Books:

1. **"Photoelasticity Vol I and Vol II**, M.M.Frocht, John Wiley &\ sons.
2. **"Strain Gauge Primer",** Perry and Lissner,
3. **"Photo Elastic Stress Analysis",** Kuske, Albrecht & Robertson John Wiley & Sons.
4. **"Motion Measurement and Stress Analysis",** Dave and Adams,

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.

BTME16F6700A	**FLUID MACHINERY LAB**	16	HC	0	0	2	2	3

	Internal Assessment	Semester End Exam
Prerequisites: Fluid Mechanics	20 Marks	30 Marks

Course Objectives:

1. To provide practical knowledge in verification of principles of fluid flow
2. To impart knowledge in measuring pressure, discharge and velocity of fluid flow
3. To understand major and minor losses.
4. To gain knowledge in performance testing of hydraulic pumps and turbines

Course Out comes:

After completion of the course the student will be able to

1. Define fluid flow principles.
2. Analyze the performance of the fluid machineries.
3. Measure the quantity of flow or discharge
4. Calculate efficiency of the fluid flow devices

Course Content:

PART-A

(Individual Experiments)

1. Determination of coefficient of friction of flow in a pipe.
2. Determination of minor losses in flow through pipes.
3. Determination of force developed by impact of jets on vanes.
4. Calibration of flow measuring devices:
   a. Orifice plate meter b. Nozzle c. Venturi meter d. V-notch

PART-B

(Group Experiments)

5. Performance testing of Turbines
   a. Pelton Wheel b. Francis Turbine c. Kaplan Turbine
6. Performance testing of Pumps
   a. Single stage/Multistage Centrifugal pumps b. Reciprocating pumps
7. Performance test of a two stage Reciprocating Air Compressor.
8. Performance test on a Air Blower.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.

BTME16F6700B	**COMPUTER AIDED MODELING AND ANALYSIS LABORATORY**	16	HC	0	0	2	2	3

	Internal Assessment	Semester End Exam
Prerequisites: FEM, SOM	20 Marks	30 Marks

Course Objectives:

1. To provide sound knowledge of stress, displacement, deformation and load distribution of the beam.
2. To familiarize with the stress concentration factor.
3. To provide capability to analyze and solve practical problems based on the concept of principle of super position.
4. To analyze complex trusses problems & its application in the real world scenario.
5. Carryout dynamic analysis of complex problems.
6. Conduct experiments related to Fixed – fixed beam for natural frequency determination.
7. To carryout thermal analysis in order to determine the heat flux and temperature distribution of the domain.
8. To analyze theoretically by using mathematical equations.

Course Outcomes:

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

1. Understanding of the basic concept of stress, displacement, deformation and load distribution of the beam.
2. Capability to analyze effect of stress concentration factor.
3. Capability to analyze and solve practical problems of concept of stepped & tapered bar.
4. Capability to analyze complex trusses problems.
5. Capability to analyze and provide solutions for the dynamic problems associated with various conditions.
6. Familiarization with the experimental methodology and ability to solve problems of fixed beam for natural frequency determination.

PART – A

Study of a FEA package and modeling stress analysis of

a Bars of constant cross section area, tapered cross section area and stepped bar (Minimum 6 Exercises)

b. Trusses –(Minimum 2 exercises)

c. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises)

PART – B

d. Stress analysis of a rectangular plate with a circular hole

e. Thermal Analysis – 1D & 2D problem with conduction and convection boundary Conditions (Minimum 4 exercises)

f. Dynamic Analysis

- Fixed – fixed beam for natural frequency determination
- Bar subjected to forcing function

- Fixed – fixed beam subjected to forcing function

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6800A	**ENERGY CONVERSION LAB**	16	HC	0	0	2	2	3
Prerequisites: Applied Thermodynamics		Internal Assessment		Semester End Exam				
		20 Marks		30 Marks				

Course Objectives:

1. To study the properties of the lubricants and fuels.
2. To know the performance of the engines.
3. To study the performance of the engines under various loading conditions.
4. To calculate various engine parameters.

Course Out comes:

After completion of the course the student will be able to

1. Identify various types of engines.
2. Define various engine parameters.
3. Analyze the engine for different loading conditions.
4. Compare the engines and select the engine on the basis of the performance

Course Content:

PART – A

1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleavland's (Open Cup) Apparatus.
2. Determination of Calorific value of solid, liquid and gaseous fuels.
3. Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers.
4. Valve Timing/port opening diagram of an I.C. engine (4 stroke/2 stroke).
5. Use of Planimeter

PART - B

1. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio and heat balance sheet for

a) Four stroke Diesel Engine
b) Four stroke Petrol Engine
c) Multi Cylinder Diesel/Petrol Engine, (Morse test)
d) Two stroke Petrol Engine
e) Variable Compression Ratio I.C. Engine.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F6800B	**HEAT & MASS TRANSFER LAB**	16	HC	0	0	2	2	3
Prerequisites: Thermodynamics & Fluid Mechanics		Internal Assessment		Semester End Exam				
		20 Marks		30 Marks				

Course Objectives:

1. To conduct the experiments to know modes of heat transfer and to find rate of heat transfer.
2. To find the heat transfer coefficient of air under natural and forced convection mode.
3. To know the use of fins and their performance.
4. To know the performance of various heat transfer devices.
5. To study the performance of the refrigerator and air conditioner.

Course Outcomes:

After completion of the course the student will be able to

1. Define the various modes of heat transfer.
2. Conduct the experiments to know the thermal properties of the materials.
3. Judge the mode of heat transfer which is effective for a particular application.
4. Determine the amount of heat transfer in a particular medium.

Course Content:

PART – A

1. Determination of Thermal Conductivity of a Metal Rod.
2. Determination of Overall Heat Transfer Coefficient of a Composite wall.
3. Determination of Effectiveness on a Metallic fin.
4. Determination of Heat Transfer Coefficient in a free Convection on a vertical tube.
5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
6. Determination of Emissivity of a Surface.

PART – B

1. Determination of Steffen Boltzmann Constant.
2. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow
3. Heat Exchangers

4. Experiments on Boiling of Liquid and Condensation of Vapour
5. Experiment on Transient Conduction Heat Transfer
6. Performance study of Vapour compression refrigerator test rig
7. Performance study of Vapour compression Air-conditioner test rig

SEVENTH SEMESTER

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7100	**CONTROL SYSTEM**	16	HC	2	1	0	3	4
Prerequisites: Laplace Transformation, Differentiation		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To understand the fundamentals related to automatic control, open and closed loop systems and feedback systems and their applications in real time.
2. Use of mathematical tool like Laplace transforms to analyze the system theoretically.
3. Representation of actual system in terms of physical model and mathematical model by writing mathematical equations.
4. To understand the behavior of the system for various inputs under time domain and frequency domain.
5. To analyze the performance and stability by using plots like polar plot, bode plot and root locus techniques.
6. Student has to understand the actual system and be able to analyze the system and give suitable solution.

Course Outcomes:

After Completion of the course the student will be able to

1. Able to understand practical aspects of automation needs of automation, field of automation.
2. Student can model the real time system into mathematical model which will helpful to design cost effective sophisticated device.
3. He may analyze the device in terms of mathematical model and test the model by using various techniques under time domain and frequency domain.
4. Able to use graphical techniques like Bode plot, Nyquist plot and root locus plot to check the stability of the model theoretically, after satisfaction of the result, the physical model can be developed and which will perform as per the requirement.
5. Through understanding of the subject will build the confidence to work in R&D Institutions or to become consultant.

Course Outcomes:

UNIT -1: **[12 hrs]**

Introduction: Concepts of automatic controls, Types of control systems, open and closed loop systems with examples, feedback system. Requirement of an ideal control system.

Mathematical Models: Models of mechanical systems, Transfer function, Numerical on mechanical system and transfer function, Block Diagrams: block representation of system elements, reduction of block diagrams.

UNIT -2: **[12 hrs]**

Signal flow graphs: Mason's gain formula, numerical.

Time Response Analysis: Transient and Steady State Response Analysis: types of inputs, first order and second order system response to step, ramp and impulse inputs, (no derivation), time response specifications and concepts of time constant, numerical problems, System stability: Routh's-Hurwitz Criterion, numerical problems.

UNIT – 3: **[12 hrs]**

Frequency Response Analysis: Polar plots, Nyquist Stability Criterion, Stability Analysis, phase and gain margin, Stability Analysis using Bode plots, Simplified Bode Diagrams.

UNIT -4: **[12 hrs]**

Root locus plots: Definition of root loci, general rules for constructing root loci, Analysis using root locus plots.

Types of controller & compensation techniques: proportional controller, differential controller, PI, PD & PID controllers, series, parallel, lead, lag, lead & lag compensation

Text Books:

1. **Modern Control Engineering** K. Ogatta. Pearson education, 2003
2. **Control Systems principles & design** M.Gopal**,** TMH, 2000

Reference Books

1. **Control Systems** I.J.Nagarath & M.Gopal New age International Publishers

2. **Feedback Control Systems** Schaum's series 2001

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7200	**MECHANICAL VIBRATIONS**	16	HC	2	1	0	3	4
Prerequisites: Mathematics, Dynamics of machines		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To know the basics of vibration.
2. To study the un-damped and damped free vibration.
3. To study the forced vibrations.
4. To study the multi degrees of freedom system.
5. To study the vibration measuring instruments.

Course Outcome:

After completion of the course the student will be able to

1. Write differential equation of the given vibration model.
2. Know about damping, natural frequency and resonance.
3. Know about response of the vibrating system.
4. Know about multi degrees of freedom systems.
5. Know about vibration measurement.

Course Outcomes:

UNIT – 1 **[12 hrs]**

Introduction: Types of vibrations, Definitions, Simple Harmonic Motion (S.H.M.), Principle of super position applied to SHM, Beats, Fourier theorem and simple problems.

Undamped (Single Degree of Freedom) Free Vibrations: 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 and Problems.

UNIT – 2 **[12 hrs]**

Damped free vibrations (1DOF): Types of damping**,** Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and Problems.

Forced Vibrations (1DOF): 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, Problems.

UNIT –3 **[12 hrs]**

Vibration Measuring Instruments and Whirling of shafts: Seismic Instruments – Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Whirling of shafts with and without damping, discussion of speeds above and below critical speeds and Problems.

Systems with two degrees of Freedom: 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, Undamped dynamic vibration absorber and Problems.

UNIT – 4 **[12 hrs]**

Numerical Methods for multi degree freedom of systems: Introduction, Maxwell's reciprocal theorem-Statement, Influence coefficients, Dunkerley's method, Stodola method, Holzer's method, Orthogonality of principal modes, method of matrix iteration and Problems.

Modal analysis and Condition Monitoring: Machine maintenance techniques, condition monitoring and diagnosis, Signal analysis, dynamic testing of machines and structures, Experimental modal analysis.

Text Books:

1. **Mechanical Vibrations,** S. S. Rao, Pearson Education Inc, 4th edition, 2003.
2. **Mechanical Vibrations,** V. P. Singh, Dhanpat Rai & Company, 3rd edition, 2006.

Reference Books:

1. **Mechanical Vibrations,** G. K.Grover, Nem Chand and Bros, 6th edition, 1996.
2. **Theory of Vibration with Applications,** W. T. Thomson, M. D. Dahleh and C. Padmanabhan, Pearson Education Inc, 5th edition, 2008.
3. **Mechanical Vibrations:** S. Graham Kelly, Schaum's outline Series, Tata McGraw Hill, Special Indian Edition, 2007.
4. **Theory and Practice of Mechanical Vibrations:** J. S. Rao & K. Gupta, New Age International Publications, New Delhi, 2001.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7300	**OPERATION RESEARCH**	16	HC	2	1	0	3	4
Prerequisites: Mathematics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Fundamentals of OR, Formulation of an LPP.

2. To determine the optimal solution for a LPP Problem by using simplex, Big-M , Integer Programming , Duality.
3. Applications of LPP such as transportation problem , Assignment problem , travelling salesman problem in order to determine the minimum cost, maximum profit of transporting the commodity, assigning of jobs to machines and also to determine the minimum distance travelled by the salesman.
4. To analyze the waiting line model for real world applications.
5. To determine the project completion time by using PERT and CPM.
6. To know the scheduling of machines in the shop floor by using Johnson's algorithm.
7. To know the conflict between the two players in a game and also to identify the best strategy for the play.

Course Outcomes:

After completion of the course the students will be able

1. Apply the various optimizing techniques in order to determine the optimal solution for the given real world problem in order maximize the profit or minimize the loss.
2. A Key tool for decision making of real world problems.

Course Content:

UNIT -1 **[12 hrs]**

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, Artificial Variable technique, BIG-M, , Concept of duality, Special cases such as unbounded solution, multiple optimal solution, infeasible solution &degeneracy

UNIT – 2 **[12 hrs]**

Transportation Problem: 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, special application problems on assignment model. Travelling salesman problem.

UNIT -3 **[12 hrs]**

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, Concepts of cost in project and crashing of networks. Simple problem on crashing.

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 problems

UNIT -4 **[12 hrs]**

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., Mx 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.

Text Books:

1. **Operations Research**, Prem kumar gupta and D.S.Hira, S.Chand Publication, New Delhi.
2. **Operations Research**, S.D.Sharma , Kedarnath ramanth & co.,

Reference Books:

1. **Introduction to operation research**, Hiller and liberman, Tata McGraw hill.
2. **Operation Research and Introduction**, Taha.H.A, Pearson education edition.
3. **Operation Research: principles and practice**: Ravindran, Phillips and Solberg, wiley india ltd, 2nd edition 2007.
4. **Operation research** by Kalavathy, Vikas publications.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7410	**CRYOGENIC ENGINEERING**	16	SC	4	0	0	4	4
Prerequisites: Refrigeration & Air Conditioning		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To introduce students to low temperature engineering and behavior of materials.
2. To develop students' skills to perform the analysis and design of cryogenic systems and cryo vessels.
3. To enable the students study the principles of cryogenic instrumentation.
4. To introduce students to cryogenic applications.

Course Outcomes:

After the completion of the course the Student will be able to

1. Define and identify the application of cryogenics.
2. Design cryogenic systems and cryo vessels.
3. Analyze the system.
4. Demonstrate the knowledge of cryogenic instrumentation
5.

Course content:

UNIT -1 Introduction to Low Temperature Engineering: **[12 hrs]**

Cryogenics – Principles of cryogenics – Methods of production of low temperature – Cryogenic fluids – Superconductivity and its applications – Super fluidity – Low temperature properties of structural materials – Applications of Cryogenics.

UNIT -2 Gas Liquefication and Cryogenic Systems **[12 hrs]**

Liquefaction of gases – Linde Hampson system – Claude system – Heylandt system – Critical components of liquefiers,– Cryo coolers – Stirling Cryocooler – Gifford – McMahon cryo cooler – Pulse tube cryo cooler – Thermodynamic analysis of above systems.

UNIT -3 Gas Separation and Purification Systems **[12 hrs]**

Properties of mixtures – Principles of gas separation, Air, Hydrogen and Helium separation systems – Gas purification methods. Ultra low temperature refrigerators, magneto caloric refrigerator, 3He-4Hedilution refrigerator, Pomeranchuk cooling

UNIT -4 Storage and Transfer Systems **[12 hrs]**

Design of cryovessels – Concept of vapour coated shields – Cryogenic insulation – Vacuum, powder, multilayer insulation, Micro-sphere insulation. Cryogenic fluid transfer- transfer lines, pressurization, Transfer pump.

Cryogenic Instrumentation: Temperature, pressure, flow and level, measurement at low temperature – Cryostats – Cold electronics.

Text Book:

1. **Cryogenic Systems**, Randall F. Barron, (1999), Oxford University Press, New York.
2. **Cryogenic Systems**, Thomas M Flynn, Marcel Dekker, Inc N.Y. Basal 1997

Reference:

1. **Cryogenic Fundamentals,** Haselden, G.G. (1999), Academic Press Inc., London

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7420	**PRODUCT DESIGN AND DEVELOPMENT**	16	SC	4	0	0	4	4
Prerequisites: None		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives::

1. To demonstrate the awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
2. Ability to coordinate multiple, interdisciplinary tasks in. order to achieve a common objective

Course Outcomes:

After completion of this course, students will be able to:

1. Identify and analyze the product design and development processes in manufacturing industry.
2. Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.
3. Analyze, evaluate and apply the methodologies for product design, development and management.
4. Undertake a methodical approach to the management of product development to satisfy customer needs.
5. Carry out cost and benefit analysis through various cost models.

Course Content:

UNIT -1: Introduction to Product Design, & processes [12 hrs]

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.

Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

UNIT -2:Product Planning, Customer needs and product specification: [12 hrs] **Product Planning:** The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

UNIT -3 Concept Generation, Selection and Testing: [12 hrs]

Concept Generation: The activity of concept generation clarifies the problem, search externally, search internally, explore systematically, reflect on the results and the process.

Concept Selection: Overview of methodology, concept screening, and concept scoring,

Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

UNIT -4: Product design and manufacturing [**12 hrs]**

Industrial Design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Text Books:

1. **Product Design and Development** - Karl.T.Ulrich, Steven D Eppinger - Irwin McGrawHill – 2000.
2. Sameul Eilon – **Elements of Production Planning and Control** – McMillan and Company,1962.
3. Jones S.W., **Product Design and Process Selection**, Butterworth Publications, 1973

Reference Books:

1. Harry Nystrom – **Creativity and Innovation**, John Wiley & Sons, 1979
2. George E. Dieter, Engineering Design – **Materials and process approach**, Tata McGraw-Hill,3rd Edition , 2000.
3. Donald E. Carter – **Concurrent Engineering**, Addison Wesley, 1992

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7430	**ENGINEERING ECONOMICS & FINANCIAL MANAGEMENT**	16	SC	4	0	0	4	4
Prerequisites: None		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To understand principles and techniques of economic evaluation indifferent field of engineering
2. To know the assessment procedure for the financial position of an organization.
3. To understand meaning of internet, CFD, time value of the money**.**

Course Outcomes:

After completion of the course the student will be able to

1. Calculate NPV,NPW, EAW and compare and select best project.
2. Calculate EMI, internet and IRR to understand time value of the money.
3. Prepare budget, financial ratio’s etc,.

Course Content:

UNIT– 1 [**12 hrs]**

Introduction: 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, Simple interest, Compound interest, Cash – flow diagrams, Personal loans and EMI Payment, Exercises and Discussion.

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, Pay-back comparison, Exercises, Discussions and problems.

UNIT – 2 [**12 hrs]**

Equivalent Annual-Worth Comparisons: Equivalent Annual-Worth Comparison methods, Situations for Equivalent Annual-Worth Comparisons, Consideration of asset life, Comparison of assets with equal and unequal lives, Use of shrinking fund method, Annuity contract for guaranteed income, Exercises, Problems.

Rate-of-Return Calculations And Depreciation: Rate of return, Minimum acceptable rate of return, IRR, IRR misconceptions, Cost of capital concepts. Causes of Depreciation, Basic methods of computing depreciation charges, Tax concepts, and corporate income tax.

UNIT – 3 [**12 hrs]**

Estimating and Costing: Components of costs such as Direct Material Costs, Direct Labor Costs, Fixed Over-Heads, Factory cost, Administrative Over-Heads, First cost, Marginal cost, Selling price, Estimation for simple components. **Introduction, Scope Of Finance, Finance Functions:** Statements of Financial Information: Introduction, Source of financial information, Financial statements, Balance sheet, Profit and Loss account, relation between Balance sheet and Profit and Loss account. Simple Numerical

UNIT – 4 [**12 hrs]**

Financial Ratio Analysis: Introduction, Nature of ratio analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Evaluation of a firm's earning power. Simple numerical

Financial And Profit Planning: Introduction, Financial planning, Profit planning, Objectives of profit planning, Essentials of profit planning, Budget administration, type of budgets, preparation of budgets, advantages, problems on flexible budget, cash budget and production budget. Introduction to Bench Marking of Manufacturing Operation.

Text Books:

1. **Engineering Economy,** Riggs J.L., 4TH ed. , McGraw Hill, 2002
2. **Engineering Economy,** Thuesen H.G. PHI , 2002

Reference Books:

1. **Engineering Economy,** Tarachand, 2000.

2. **Industrial Engineering and Management**, OP Khanna, Dhanpat Rai & Sons. 2000
3. **Financial Mangement,** Prasanna Chandra, 7th Ed., TMH, 2004
4. **Finacial Management,** IM PANDEY, Vikas Pub. House, 2002

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7440	**THEORY OF PLASTICITY**	16	SC	4	0	0	4	4
Prerequisites: Theory of Elasticity		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To known yield criteria for ductile metal.
2. To understand the plastic stress-strain relations.
3. To learn Upper and lower bound theorems and corollaries.
4. To solve Simple forms of indentation problems using upper bounds.

Course Outcomes:

After completion of the course the student will be able to

1. Demonstrate Idealized stress-strain diagrams for different material models
2. Demonstrate experimental verification of the Prandtl-Rouss equation
3. Solve Problems of metal forming

Course Content:

UNIT – 1 **[12 hrs]**

Fundamental of Elasticity: Concept of stress, stress transformation laws, spherical and deviator stress tensors, equilibrium equations, octahedral stresses, concept of strain, deviator and spherical strain tensors, strain transformation laws, octahedral strains, generalized Hooke's law, elastic strain energy, compatibility equations, theories of strength. Problems.

Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, recrystallization and grain growth, flow figures or luder's cubes.

UNIT–2 **[12 hrs]**

Cubical Dilation, True Stress And Strain: Strain tensor, principal strain, plane strain, spherical and deviator strain, octahedral strain and representative strain, problems.

Stress Strain Relations: Introduction, types of materials, empirical equations, theories of plastic flow, experimental verification of St.Venant's theory of plastic flow, the concept of plastic potential, the maximum work hypothesis, mechanical work for deforming a plastic substance.

UNIT–3 **[12 hrs]**

Yield Criteria: Introduction, yield or plasticity conditions, Von Mises and Tresca criteria, Geometrical representation, yield surface, yield locus (two dimensional stress space), experimental evidence for yield criteria, energy required to change the shape with basic principle problems.

Slip Line Field Theory: Introduction, basic equations for incompressible two dimensional flow, continuity equations, stresses in conditions of plain strain, convention for slip lines, solutions of plastic deformation problem, Geometry of slip line field, Properties of the slip lines, construction of slip line nets

UNIT – 4 **[12 hrs]**

Bending Of Beams: Analysis for stresses, Non linear stress strain curve, shear stress distribution, residual stresses in plastic bending, problems.

Torsion Of Bars: Introduction, plastic torsion of a circular bar, elastic perfectly plastic material, elastic work hardening of material, residual stresses and problems

Text Books:

1. '**Theory of Plasticity',** Chakraborty 3rd Edition Elsevier.
2. **'Engineering Plasticity',** W. Johnson and P. B. Mellor D Van N.O Strand Co. Ltd 2000

Reference Books:

1. **Basic Engineering Plasticity,** DWA Rees 1st Edition Elsevier.
2. **Theory of Plasticity,** L. S. Srinath TMH,
3. **Theory of Plasticity,** Sadhu Singh, Kanna publisher

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7510	**COMPUTATIONAL FLUID DYNAMICS**	16	SC	3	0	0	3	3
Prerequisites: Fluid Mechanics, Heat Transfer, Differential and Integral mathematics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives::

1. To provide the students with sufficient background to understand the mathematical representation of the governing equations of fluid flow and heat transfer.
2. To enable the students to solve one and two-dimensional ordinary and partial differential equations using traditional CFD tools.

3. To help the students solve fluid flow field using some popular CFD techniques.

Course Outcome:

After completion of the course the student will be able to

1. Possess the knowledge of CFD techniques, basic aspects of discretization and grid generation.
2. Solve fluid flow fields using CFD methods.
3. Model fluid flow problems and heat transfer.

Course Content:

UNIT -1 Introduction and Governing Equations [12 hrs]

Introduction - Impact and applications of CFD in diverse fields - Governing equations of fluid dynamics – Continuity - Momentum and energy - Generic differential form for governing equations - Initial and Boundary conditions - Governing equations for boundry layers -Classification of partial differential equations – Hyperbolic - Parabolic - Elliptic and Mixed types - Applications and relevance.

UNIT -2 Discretization [12 hrs]

Basic aspects of discretization - Discretization techniques – Finite difference - Finite volume and Finite Element Method– Comparison of discretization by the three methods - Introduction to Finite differences three-dimensional conduction in Cartesian coordinates – Explicit - Implicit - Crank-Nicolson - ADI scheme – Stability criterion. Difference equations - Numerical errors -.truncation errors, round off error

UNIT -3 CFD Tool [12 hrs] -

Geometry-meshing-grid independent test, mesh refinement analysis, validation, results. Turbulent modeling, convergence, accuracy. Examples.

UNIT -4 Advance CFD: [12 hrs]

Introduction, large eddy simulation, direct numerical simulation, multi flow combustion, case study, future in CFD.

Text Books

1. J.D. Anderson, Jr., (2000), **Computational Fluid Dynamics – The basics with applications**, McGraw-Hill, Incs.

Reference Books

1. K. Muralidhar, T. Sundarajan, (2001), **Computatioanl Fluid Flow and Heat Transfer**, Narosa Publishing House, New Delhi.
2. S.V. Patankar, (1999), **Numerical Heat Transfer and Fluid Flow**,
3. Jiyuan Tu **Computational fluid Dynamics – A practical approach**-Elsevier publication

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7520	**NANO TECHNOLOGY AND APPLICATIONS**	16	SC	3	0	0	3	3
Prerequisites: Material Science		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To enable the students understand the basic concepts of Nanotechnology
2. To enhance the knowledge of students in nano materials
3. To familiarize the students with the properties of nano materials and their applications
4. To expose the students MEMS / NEMS devices and their applications

Course Outcome:

After completion of the course the student will be able to

1. Student will be able to . Use Nano materials for various industrial applications
2. Design MEMS / NEMS devices for various applications .
3. Demonstrate the knowledge of devices used in MEMS/NEMS

Course Content:

UNIT-1: Introduction to Nano Science& Technology: [12 hrs]

Single crystal, polycrystal and a nanocrystal- Nano in nature- Significance of nanostructures-- Present and future applications of nanomaterials - Classification of nanomaterials - magic numbers-Electronic and structural magic numbers - bulk to nanotransition- Size dependent property changes- Factors leading to changes-Surface to volume ratio and quantum confinement -stabilization of nanoparticles.

UNIT -2: Synthesis, characterization of nano materials and mechanical properties: [12 hrs]

Bottom-up and top down approaches- Inert gas condensation- Ball milling and Sol –gel - lithographic techniques- Particle size determination- XRD- laser diffraction- SEM,TEM, Raman ,Infrared spectroscopies , AFM and contact angle measurement and porosimeter –phase transitions in nano systems- Inverse-Hall-Petch behaviour–mechanical properties of nanomaterials.

UNIT -3:Applications of Nanomaterials in automobiles, aerospace, energy and biomedical areas [12 hrs]

Metallic nanoparticles, Cu, Ag,Au,Pd,Rh ,Modulus and hardness, melting point depression , catalytic, antifungal and anti bacterial properties, chemical sensors ,CeO2- fuel efficiency – magnetic nanoparticles - s Metallic nanoparticles, Cu, Ag,Au,Pd,Rh ,Modulus and hardness, melting point

depression , catalytic, antifungal and anti bacterial properties, chemical sensors ,CeO2- fuel efficiency – magnetic nanoparticles

UNIT -4 : Nano machines and Nano devices: **[12 hrs]**

Microelecrtoromechanical systems- (MEMS) –Nanoelectromechanical systems (NEMS), Fabrication-nanodevices and nanomachines , molecular and supramolecular switches . Nano tribology

Text Books

1. Charles P. Poole, Frank J. Owens, (2000), **Introduction to Nanotechnology**, John Wiley & Sons.
2. **Nanomaterials:Synthesis, properties and applications** C.N.R.Rao, P.J.Thomas and U.Kulkarni, Springer-Verlag (2007)

Reference Books

1. **Nanocrystalline materials**,Glieter, Progress in Materials Science Vol. 33, pp. 223-315, 1989
2. **Mechanical alloying and milling**, C. Suryanarayana, Progress in Materials Science 46 (2001) 1,184

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7530	**TRIBOLOGY & BEARING DESIGN**	16	SC	3	0	0	3	3
Prerequisites: Fluid Mechanics		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To provide broad based understanding of the interdisciplinary subject 'tribology' and its technological significance
2. To understand the nature of engineering surfaces, their topography and learn about surface characterization techniques.
3. To learn about the contact of solid surfaces and their interactions
4. To understand the genesis of friction, laws of sliding and rolling friction
5. To learn about consequences of wear, wear mechanisms, wear theories and analysis of wear problems
6. To learn about the principles of lubrication, lubrication regimes, theories of hydrodynamic, elasto hydrodynamic and mixed/ boundary lubrication
7. To learn about tribo testing and experimental techniques in tribology
8. To learn about tribology of different machine components

Course Outcomes:

After completion of the course the student will be able to

1. Demonstrate basic understanding of friction, lubrication, and wear processes.
2. Use mathematical tools to analyze tribological processes.
3. Become familiar with common anti-friction and anti-wear components and the lubricants used therein.
4. Describe the detailed operation of selected anti-friction or anti-wear components
5. Design a tribological system for optimal performance.
6. Develop technical project reports and technical presentations

Course Contents:

UNIT – 1 Introduction To Tribology: [12 hrs]

Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants.

Hydrodynamic Lubrication: Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, mechanism of pressure development in an oil film, Reynold's investigation and Reynold's equation in 2D.

UNIT – 2 Idealized Journal Bearing: [12 hrs]

Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's numbers and significance of it; Partial bearings, end leakages in journal bearing, numerical problems.

Slider / Pad Bearing With A Fixed And Pivoted Shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, numerical examples.

UNIT – 3 Oil Flow And Thermal Equilibrium Of Journal Bearing: [12 hrs]

Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings.

Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing.

UNIT - 4 Bearing Materials: [12 hrs]

Commonly used bearings materials, properties of typical bearing materials. Advantages and disadvantages of bearing materials.

Behavior Of Tribological Components: Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering.

Text Books

1. **Fundamentals of Tribology** , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2006
2. **Introduction to Tribology Bearings,** Mujumdar B. C., S. Chand company pvt. Ltd 2008.

Reference Books

1. **Theory and Practice of Lubrication for Engineers,** Fuller, D., New York company 1998
2. **Principles and Applications of Tribology,** Moore, Pergamaon press 1998
3. **Tribology in Industries,** Srivastava S., S Chand and Company limited, Delhi 2002
4. **Lubrication of bearings – Theoretical Principles and Design,** Redzimovskay E I., Oxford press company 2000

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7540	**AUTOMATION IN MANUFACTURING**	16	SC	3	0	0	3	3
Prerequisites: Manufacturing science and CIM		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. The aim of the course is to define the concept of automation and building blocks, Fundamentals of manufacturing.
2. To specify the components of automated production, group technology and cellular manufacturing concept.
3. To explain the types of transfer mechanism that may be used for work part transfer.
4. To outline how storage buffers can be deployed in automated production line
5. To explain the concept of automated assembly system.
6. To enable a student of course from industry to develop new methodologies for
7. Application in industry.

Course Outcomes:

After completion of the course the student will be able to

1. Evaluate the product and production relationships.
2. Understand the cost of manufacturing operations.
3. Involve in the design of transfer mechanisms that may be need for work part transfer in manufacturing sector.
4. Evaluate the utilization and availability of the infrastructure in the automated production line (APL).
5. understand the new automation technologies like Group Technology (GT), Bar code systems, Lean manufacturing, JIT, Agile manufacturing.
6. Implement the concept of Line balancing.
7. Understand the modern automated industries requirements.

Course Content:

UNIT – 1 **[12 hrs]**

Introduction: Production System Facilities, Automation definition, type and reason, Manuel labour in production system, product and production relationship, cost of manufacturing operation.

Industrial Control System: 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 **[12 hrs]**

Material Handling : Overview, principle, material transportation system and storage system

Automated Manufacturing Systems: Components of a Manufacturing systems, Classification of Manufacturing Systems, overview of Classification Scheme, Single Station Manned Workstations and Single Station Automated Cells.

UNIT – 3 **[12 hrs]**

Group Technology & Flexible Manufacturing Systems: Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing, Flexible Manufacturing Systems: What is an FMS, FMS Components, FMS Applications & Benefits, and FMS Planning & Implementation Issues.

Quality Control Systems: Traditional and Modern Quality Control Methods, Taguchi Methods in Quality Engineering. Introduction to SQC Tools.

UNIT – 4 **[12 hrs]**

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

Manufacturing Support System: Process Planning, Computer Aided Process Planning, Concurrent Engineering & Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean and Agile manufacturing.

Text Books

1. **Automation, Production Systems and Computer Integrated Manufacturing,** M. P. Groover, Pearson education. Third Edition, 2008
2. **Principles of CIM,** Vajpayee, PHI.

Reference Books

1. **Anatomy of Automation**, Amber G.H & P. S. Amber, Prentice Hall.
2. **Performance Modeling of Automated Manufacturing Systems,** Viswanandham, PHI
3. **Computer Based Industrial Control**, Krishna Kant, EEE-PHI

OPEN ELECTIVE

(FOR STUDENTS OF OTHER SCHOOLS)

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7610	**INDUSTRIAL AUTOMATION AND PRODUCTION SYSTEMS**	16	OE	4	0	0	4	4
Prerequisites: None		Internal Assessment				Semester End Exam		
		40 Marks				60 Marks		

Course Objectives:

1. The aim of the course is to define the concept of automation and building blocks, fundamentals of manufacturing.
2. To specify the components of automated production, group technology and cellular manufacturing concept.
3. To explain the types of transfer mechanism that may be used for work part transfer.
4. To outline how storage buffers can be deployed in automated production line
5. To explain the concept of automated assembly system.
6. To enable a student of course from industry to develop new methodologies for application in industry.

Course Outcomes:

After completion of the course the student will be able to

1. Evaluate the product and production relationships.
2. Understand the cost of manufacturing operations.
3. Involve in the design of transfer mechanisms that may be need for work part transfer in manufacturing sector.
4. Evaluate the utilization and availability of the infrastructure in the automated production line (APL).
5. Understand the new automation technologies like Group Technology (GT), Bar code systems, Lean manufacturing, JIT, Agile manufacturing.
6. Implement the concept of Line balancing.
7. Understand the modern automated industries requirements.

Course Content:

UNIT-1 **[12 hrs]**

Introduction: Automation, Production System Facilities, Manufacturing Support systems, Automation in Production systems, Reasons for automating, Automation principles, Ten Strategies, Migration Strategies.
Manufacturing Operations: Product/Production Relationship, Production concepts and Mathematical Models, Costs of Manufacturing Operations, Problems.

UNIT-2 [**12 hrs]**
Industrial Control Systems: Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automation, Continuous versus Discrete control.
Material Handling and Identification Techniques: Industrial trucks, Automated guided vehicle systems, Monorails and other rail guided vehicles, Conveyor systems, Cranes and hoists, Automated storage systems, Bar code technology.

UNIT-3 [**12 hrs]**
Group Technology & Flexible Manufacturing Systems: Part Families, Parts Classification and coding, Production Flow Analysis, FMS, FMS Components, FMS Applications & Benefits, FMS Planning & Implementation Issues.

Quality Control Systems: Traditional and Modern Quality Control Methods, Taguchi Methods in Quality Engineering, Introduction to SQC, SQC Tools.

UNIT-4 [**12 hrs]**
Inspection Technologies: Automated Inspection, Coordinate Measuring Machines Construction (CMM), operation & Programming, Software, Application & Benefits, Flexible Inspection System, Inspection Probes on Machine Tools, Machine Vision, and Optical Inspection Techniques & Noncontact Non-optical Inspection Technologies.
Manufacturing Support System: Process Planning, Computer Aided Process Planning(CAPP), Concurrent Engineering (CE), Design for Manufacturing (DFM), Just-in Time Production System (JIT), Basic concepts of lean and Agile manufacturing, Comparisons of Lean & Agile Manufacturing.

Text Books:
1. **Automation, Production Systems and Computer Integrated Manufacturing**, M. P. Groover, Pearson education. Third Edition, 2008
2. **Principles of CIM**, Vajpayee, PHI.

Reference Books:
1. **Anatomy of Automation**, Amber G.H & P. S. Amber, Prentice Hall.
2. **Performance Modeling of Automated Manufacturing Systems**, Viswanandham, PHI
3. **Computer Based Industrial Control**, Krishna Kant, EEE-PHI

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7620	**INDUSTRIAL ENGINEERING**	16	OE	4	0	0	4	4
Prerequisites: None		Internal Assessment		Semester End Exam				

	40 Marks	60 Marks

Course Objectives:

1. Fundamentals of Industrial Engineering, Application of Work study in the shop floor.
2. To know the concepts of method study and work measurement with their relative technique.
3. To understand and learn the various application of industrial engineering techniques for the day to day process.
4. To determine the standard time for the specified job.
5. To access the value for a particular product
6. To know about the depreciation and equipment replacements concepts in detail.

Course outcomes:

After completion of the course the students will be able to

1. Apply the various techniques in order to analyze the production system with respects to industrial scenario.
2. Take right decisions to optimize the resource utilization by improving productivity of the lands, buildings, peoples, materials, machines, money, methods and management effectively.
3. Eliminate unproductive activities under the control of management, supervisor, worker and design of the products and processes.
4. Use the charts to record the activities of the people, materials and equipment to find alternate methods which minimize the waste and implement the best method.
5. Improve processes by applying various IE techniques and find the standard time.
6. Design man machine system to improve human efficiency and reduce the effort of the workers.
7. Apply various method of depreciation and replacement of equipment based on the cost with respect to individual or group policy.

Course Content:

UNIT-1: **[12 hrs]**

Introduction: Industrial Revolution and historic development of the factory system. Productivity and its index, effectiveness and efficiency, various types of productivity, partial, total factor and total productivity, productivity cycle, productivity improvement techniques Production system and its types.

Plant location and layout: Factors influencing plant location, location economics, selection of specific site. Plant layout: Objectives of plant layout, principles of plant layout, types of plant layout, their merits and demerits, Evaluation of Layouts.

UNIT-2 **[12 hrs]**

Work study and its techniques: Definition of work study and method study, Basic procedure of work study and method study. Use of recording techniques such as outline process , flow process chart, Two handed process chart, multiple activity chart, man-machine chart.

Work Measurement: Definition, Common steps in work measurement, Time study method, breaking the task into work elements, types of elements, rating and different methods of rating.

Allowances and its types. Calculation of basic time and standard time with numerical.

UNIT-3 [**12 hrs]**

Work sampling: Principles, Procedure, confidence limits, number of observations required, advantages and disadvantages, applications. Ergonomics: Human factors in the design of workplace, layout of equipment, design of displays and controls.

Quality and Value Engineering: Quality definition, quality attributes,7QC tools, quality costs, ISO certification process and its benefits. Value engineering- definition , kinds of value, key elements, value engineering job plan, life cycle cost and product life cycle.

UNIT-4 [**12 hrs]**

Depreciation – Definition, factors, Types and methods of Depreciation with numerical.

Equipment Replacement: Nature of replacement problems, economic life of challenger and defender, Replacement of items – individual replacement and group replacement

Text Books:

1. **Introduction to Work study**, ILO(International Labor organization)
2. **Industrial Engineering and Economy** , O.P.Khannan, PHI Publisher

Reference Books:

1. **Hand book of Industrial Engineering** , Maynard
2. **Motion and time study**, Ralph.M.Barnes, John Wiley.
3. **Motion and time study** , Marvin.E.Mundel ,

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7700	**CIM AND AUTOMATION LAB**	16	HC	0	0	2	2	3
Prerequisites: Manufacturing Technology CAD/CAM/CIM		Internal Assessment 20 Marks			Semester End Exam 30 Marks			

Course Objectives:

1. To train the students with part programming concepts
2. Generation of manual part programming – CNC Turn and CNC mill
3. Generation of tool path and NC part program by using part Geometry.

Course Outcomes:

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

1. Generate the part program for the given profile/part geometry – offline
2. Able to work on CNC machines.

Course Contents:

CNC, Part Programming using CAM packages simulation of Turning, Drilling and milling operations. Simulations to be carried out using simulation packages like Master CAM, Edge CAM, Cadem , MTAB or any equivalent software. (Model should consist of Minimum 4 operations).

DEMO of Flexible Manufacturing system, ASRS, AGVS Robot Programming, Hydraulic and pneumatic, basics of these topics to be conducted.

Reference: Manual prepared by REVA University Faculty.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F7800	**DESIGN LAB**	16	HC	0	0	2	2	3
Prerequisites: Theory of Machines and vibration		Internal Assessment			Semester End Exam			
		20 Marks			30 Marks			

Course Objectives:

1. To learn the testing procedure in design field.
2. To know the frequency of the rotating objects
3. To know the stress and strain in the component when it undergoes various types of loads.
4. To understand the stress concentration in the elements.
5. To learn the use of strain gages and its working principle

Course Outcomes:

After completion of the course the student will be able to

1. Define frequency, critical speed and terminologies used in the dynamics of the machines.
2. Determine the stress and strain in the component.
3. Analyze the governors.
4. Define stress concentration and its importance and determine the stress concentration factor.

Course Contents:

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. Determination of critical speed of a rotating shaft.
3. Determination of Fringe constant of Photo elastic material using.
    a) Circular disc subjected to diametrical compression.
    b) Pure bending specimen (four point bending)
4. Determination of stress concentration using Photo elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook.
5. Balancing of rotating masses.

PART – B

6. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
7. Determination of stresses in beam using strain gauge
8. Determination of pressure distribution in journal bearings
9. Determination of equilibrium speed, sensitiveness , power and effort of porter governor
10. Experiment on Gyroscope (demonstration only)

EIGHTH SEMESTER

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F8100	**SAFETY MEASURES IN MECHANICAL ENGINEERING**	16	HC	3	0	0	3	3
Prerequisites: Basic knowledge on manufacturing process and Machines		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1) To know the reasons for accidents happen in mechanical Industries
2) To understand the safety procedure to avoid accidents
3) To know the safety rules and regulations.
4) To understand the various acts of Govt of India.
5) To know the responsibility as a citizen, employer, employee and head of the family

Course Outcomes:

After completion of the course the student will be able to

1) Define various reasons for industrial accidents.
2) Predict type of accident may occur.
3) Use various safety rules during the work.
4) Act as a responsible person.

Course Contents:

UNIT-1 ACCIDENTS & SAFETY [12 hrs]

Definitions and theories.- Accident - Injury - Unsafe act - Unsafe condition -Dangerous occurrence - Theories and principles of accident causation - Cost of accidents - Accident reporting and investigations - Safety committees - Need - Types- Advantages. Safety education and training - Importance - Various training methods -Accident prevention - Motivating factors - Safety suggestion schemes. Safety performance - Definitions connected with measuring safety performance as per Indian and International standards.

UNIT- 2 SAFETY IN MECHANICAL HANDLING [12 hrs]

General safety consideration in material handling - Ropes, Chains, Sling, Hoops, Clamps, arresting gears - Prime movers. Ergonomic consideration in material handling, design, installation, operation and maintenance of conveying equipments, hoisting, traveling and slewing mechanisms. Selection, operation and maintenance of industrial trucks - Mobile cranes - Tower crane.

UNIT-3 SAFETY IN STORAGE & HANDLING OF CHEMICALS AND GASES [12 hrs]

Safety in the design process of chemical plants - Safety in operational and maintenance - Exposure of personnel - Operational activities and hazards - Safety in storage and handling of chemicals and gases - Hazards during transportation - Pipeline transport - Safety in chemical laboratories. Specific safety consideration for cement, paper, pharmaceutical, petroleum, petro - chemical, rubber, fertilizer and distilleries.

UNIT-4 REGULATIONS FOR HEALTH, SAFETY AND ENVIRONMENT [12 hrs]

Factories act and rules; - Indian explosive act - Gas cylinder rules – Environmental pollution act - Indian petroleum act and rules - Oil industry safety directorate (OISD) - Indian Electricity act and rules. - Mines act and rules - Indian motor vehicles act and rules.

Text Books

1. Handlin.W**, "Industrial Hand Book",** McGraw-Hill, 2000.
2. Anton.T.J, **"Occupational safety and health management",** (2nd Edition). New York, McGraw Hill, 1989.

Reference Books

1. Heinrich.H.W, **"Industrial Accident Prevention***",* McGraw-Hill, 1980.
2. Rudenko.N, **"Material Handling Equipments",** Mir Publishers, Moscow, 1981.
3. Lees.F.P, **"Loss "Prevention in Process Industries",** Butterworths, NewDelhi,1986.
4 **IS CODES of Oil Industry Safety Directorate**, Govt. of India.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F8210	**AUTOMOTIVE ENGINEERING**	16	SC	4	0	0	4	4
Prerequisites: IC Engines		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To broaden the understanding of students in the structure of vehicle chassis and engines.
2. To introduce students to steering, suspension, braking and transmission systems.
3. To introduce students to engine auxiliary systems like heating, ventilation and air-conditioning.
4. To teach students about the importance of alternate fuels and modifying the engine suitably.

Course Outcomes:

After completion of the course the student will be able to

1. Develop chassis and identify suitable engine for different applications
2. Formulate steering, braking and suspension systems
3. Select a suitable conventional and automatic transmission system

Course Content:

UNIT–1 **[12 hrs]**

ENGINE COMPONENTS: Basic components of engine components, importance with reference to application valve timing diagrams for SI engine and CI engine, Types of combustion chambers for S.I. Engine and C.I. Engines, methods of a Swirl generation, engine positioning, cooling requirements, methods of cooling and lubrication.

FUELS, FUEL SUPPLY SYSTEMS FOR SI ENGINES: Conventional fuels, alternative fuels, Combustion in S I and C I engines, normal and abnormal combustion, Knocking and detonation, cetane and octane numbers, Fuel mixture requirements for SI engines,

UNIT–2 **[12 hrs]**

FUEL SUPPLY SYSTEM:- Carburetor-construction and working of simple carburetor, multi point and single point fuel injection systems. Fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Fuel injection system in CI engines, CRDI System.

SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler.

IGNITION SYSTEMS: Battery Ignition systems, magneto Ignition system,. Electronic Ignition system, Ignition advance.

UNIT–3 **[12 hrs]**

POWER TRAINS: General arrangement of clutch, Principle of friction clutches, Fluid flywheel, Single plate, multi-plate and centrifugal clutches.

GEAR BOX: Necessity for gear ratios in transmission, synchromesh gear boxes, 3, 4 and 5 speed gear boxes. Free wheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epicyclic gear box, principle of automatic transmission,

DRIVE TO WHEELS: Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer.

UNIT–4 **[12 hrs]**

SUSPENSION SYSTEM AND BRAKES: Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system.

BRAKES:- Brakes and its mechanism, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit.

ENGINE EMISSIONS AND STANDARDS:- S I Engine emissions and C I Engine emissions, emission controls, Controlling the air-fuel mixture, Controlling the combustion process, Cleaning the exhaust gas, Exhaust gas recirculation, Catalytic converter, Brief discussion on Emission standards- Euro I, II, III and IV norms, Bharat Stage II, III and IV norms.

Text Books

1. William.H.Crouse, (2006), **Automotive Mechanics**, 10th Edition, McGraw-Hill.
2. Kirpal Singh, **Automobile Engineering**, Vol.1&2, Standard Publications.
3. Mathur and Sharma **Automobile Engg**

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F8220	**ROBOTICS**	16	SC	4	0	0	4	4
Prerequisites: Matrices, Theory of Machines		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Learn the concepts of robot representation using concepts of kinematics & mathematics.
2. Learn & understand the uses & limitation of robotic & vision applications.
3. Learn basic methods & algorithms of path planning for mobile robots.
4. Learn robot transformation.

Course outcome:

After completion of the course the students will be able to

1. Understand the position and orientation of the object in space in a 3 dimensional space.
2. Understand the relationship between joint variables and the position and orientation of the robot end effectors

3. Plan the trajectories for the robot end effectors to perform specific task
4. Understand the basic principle of image acquisition & image components.
5. Apply the knowledge to design actual robots to perform basic operations such as pick & place line follower robots etc.

Course Content:

UNIT-1 **[12 hrs]**

Robotics – history, definition and anatomy of robot, Introduction–Basic Structure– Classification of robot and Robotic configuration –laws of robotics – robot motions – work space, precision of movement. Types of joints : Rotary, prismatic, cylindrical & spherical joints, resolution, repeatability and accuracy of robot. Position & orientation of rigid body, universal frames & fixed frames, Euler angle representation for xyz, zyz frames.

UNIT-2 **[12 hrs]**

Mathematical representation of Robots, Kinematics of Robot : Introduction, Matrix Representation, Homogeneous transformation, forward and inverse Kinematics, Inverse Kinematics Programming, Degeneracy, dexteritying, transformation matrix for 2R and 3R manipulator, puma 560 & SCARA manipulator and standford.

UNIT-3 **[12 hrs]**

Trajectory planning & avoidance of obstacles uninformed path search, informed path search, A* & B* algorithms, bus algorithms with tactile sensors & case studies.
End Effectors:- mechanical gripper, types, hydraulic, pneumatic and electric actuators used in robot. Robot Applications: Industrial and non industrial application, mobile application, limitations and future application of robot.

UNIT-4 **[12 hrs]**

Machine Vision systems : Introduction – Image processing Vs image analysis, image Acquisition, digital Images – Sampling and Quantization – Image definition, levels of Computation.
Programming of Robots: Types of programming, on line and off line programming, types- manual and led through programming, programming languages, VAL and its commands, storing and operating, point to point tasks.

Text Book:

1. Saeed B. Niku, **Introduction to Robotics: Analysis, Systems, Applications**, 2nd edition, Pearson Education India, PHI 2003 (ISBN 81-7808-677-8)

References Book:

1. M.P. Groover, **Industrial Robotics – Technology, Programming and Applications**, McGraw-Hill, USA, 1986.
2. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, **Machine Vision**, Tata McGraw-Hill, 1991.
3. Yoremkoren, **Robotics for Engineers**, McGraw-Hill, USA, 1987.
4. P.A. Janaki Raman, **Robotics and Image Processing**, Tata McGraw-Hill, 1991.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F8230	**PROJECT MANAGEMENT**	16	SC	4	0	0	4	4
Prerequisites: Management		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To understand project management, methodology that will allow to initiate and manage the projects efficiently and effectively.
2. To know the use of project management tools, techniques and skills.
3. To understand how to manage the project cost, quality and delivery.
4. To learn the skill of selection and initiation of individual projects and portfolios of projects in the enterprise.

.**Course outcomes:**

After completion of the course the student will be able to

1. Identify specific management needs in the execution of projects at tactical and strategic level.
2. Estimate the project proposals for scope, time and cost to consider its feasibility.
3. Synthesis the strategies to evolve suitable approach to accomplish the project with effective usage of the resources.
4. Illustrate the team building and leadership skills in planning and implementation of the project.
5. Apply effective management technique in the project execution to fulfill the desired objectives.

Course Contents:

UNIT–1 **[12 hrs]**

Concept of Project Management: Concept of project, categories of projects, phase of project life cycle , roles and responsibility of a project leader, tools and technology for project management.

Organizing and Staffing: Project leader: skills/abilities required for project manager, authorities and responsibilities of project manager, project organization, types of accountability in project execution and control

UNIT – 2 **[12 hrs]**

Project Planning and Estimation: Feasibility study and report, phased planning, project planning steps: objectives and goals of the project, preparation of cost estimation, finalization of project implementation, evaluation of the project profitability.

Project Procedure Manual: Contract management, configuration management, communication management, man management , time management, materials management, cost management, needs for flexibility.

UNIT – 3 **[12 hrs]**

Project Scheduling, Coordination and Control: Project implementation, scheduling-different techniques-GANTT charts, bar charts for combined activities,Project direction, communication in a project, project coordination, project control, scope and progress control performance control, schedule control and cost control, case study .

UNIT – 4 **[12 hrs]**

Performance Measures in Project Management and Project Inventory Management: Performance indicators, performance improvement for the CM and DM companies for better project management, nature of project inventory, supply and transportation of materials.

Project Implementation: project work system design, work break down structure (WBS), project execution plan (PEP)

Text Books

1. **Project Management**, a system approach to planning, scheduling and controlling- Herold Kerzner CBS publishers and distributors, 2002
2. **Project Management-** Chaudhry S McGraw Hill 2010

Reference Books

1. **Project Management,** Harvey Maylor, 3rd edition, Pearson, 2003,

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F8240	**MECHANICS OF COMPOSITE MATERIALS**	16	SC	4	0	0	4	4
Prerequisites: Material Science		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To classify the composite materials, highlight their applications in key areas and introduce to fiber reinforced plastic processing.
2. To perform micromechanical and macro mechanical analysis of a lamina.
3. To introduce to various biaxial strength theories and macro mechanical analysis of a laminate.
4. To provide a detailed understanding of metal matrix composites including types, application, fabrication and properties.
5. To provide thorough knowledge on composites, metal matrix composites, micro/macro mechanical analysis of lamina/laminate.

Course Outcomes:

After completion of the course the student will be able to

1. Gain knowledge on classification of composites, their applications and processing.
2. Understand micro/macro mechanical analysis of lamina/laminate
3. Be familiar with various biaxial strength theories and understand macro mechanical analysis of a laminate.
4. Gain comprehensive knowledge on metal matrix composites.
5. Do Micro/Macro mechanical analysis of lamina/laminate and implement basic knowledge of composites in general and metal matrix composites in particular, in future project/Research.

Course Contents:

UNIT – 1 **[12 hrs]**

Introduction To Composite Materials: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites.

Applications: Automobile, Aircrafts. Missiles. Space hardware, Electrical and electronics, Marine, recreational and sports equipment, future potential of composites.

Fiber Reinforced Plastic Processing: Layup and curing, fabricating process, open and closed mould process, hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding.

UNIT – 2 **[12 hrs]**

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli by Rule of mixture, Numerical problems.

Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Two – dimensional relationship of compliance and stiffness matrix.

Macro Mechanics of a Lamina Hooke's law for two-dimensional angle lamina, engineering constants – Numerical problems. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

UNIT – 3 **[12 hrs]**

Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai, Wu tensor theory, Numerical problems.

Macro Mechanical Analysis of Laminate: Introduction, code, Kirchhoff hypothesis, CL T, A, B, and D matrices (Detailed derivation) , Special cases of laminates, Numerical problems**.**

UNIT – 4 **[12 hrs]**

Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC's and its application.

Fabrication Process For MMC's: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

Properties of MMC'S: Physical Mechanical, Wear, machinability and Other Properties. Effect of size, shape and distribution of particulate on properties.

Text Books

1. **Composite Science and Engineering,** K. K. Chawla Springer Verlag 1998.
2. **Mechanics of composite materials,** Autar K. Kaw CRC Press New York.

Reference Books

1. **Fiber Reinforced Composites,** P. K. Mallick, Marcel Dekker,Inc
2. **Mechanics of Composite Materials**, Robert M. Jones, McGraw Hill Kogakusha Ltd.1998
3. **Composite materials hand book,** Meing Schwaitz," McGraw Hill book company.1984
4. **Principles of composite Material mechanics,** Ronald F. Gibron. McGraw Hill international, 1994.
5. **Mechanics of Composite Materials and Structures**, Madhujit Mukhopadhyay , Universities Press 2009

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F8310	**BIOMASS ENERGY SYSTEMS**	16	SC	4	0	0	4	4
Prerequisites: Energy Resources		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Describe sources of bio mass energy and its characteristics
2. List and explain different bio mass conversion methods
3. Explain the principles of bio mass gasifiers and bio mass digesters.
4. Present the production techniques of bio diesel and its use in IC engines.

5. Explain basic thermodynamic cycle in bio power generation.

Course outcomes:

After completion of the course the student will be able to

1. Describe the fundamentals and characteristics of bio mass energy sources
2. Describe different bio mass conversion methods to use as a fuel.
3. Explain the technological basis for harnessing bio mass energy sources.
4. Extract the bio fuel from biomass.

Course Content

UNIT – 1 **[12 hrs]**

Introduction: Biomass energy sources, energy content of various Bio – fuels, Energy plantation, origin of Biomass photo synthesis process, Biomass Characteristics, sustainability of Biomass.

Biomass Conversion Methods: Agrochemical, Thermo-chemical, Biochemical (flowchart) & Explanation.

UNIT – 2 **[12 hrs]**

Physical & Agrochemical Conversion: Briquetting, Pelletization, Agrochemical, fuel Extraction, Thermo chemical Conversion: Direct combustion for heat, Domestic cooking & heating.

Biomass Gasification: Chemical reaction in gasification, Producergas& the constituents, Types of gasifiers. Fixed bed gasifiers, Fluidized bed gasifiers. Liquefaction: Liquefaction through pyrolysis & Methanol synthesis, application of producer gas in I C Engines.

UNIT – 3 **[12 hrs]**

Bio-Methanization: Anaerobic digestion, Basic principles, factors influencing Biogas yield, classification of Biogas digester, floating gasholder & fixed dome type.(Working Principle with diagram), Calculations for sizing the Biogas plant.

Biogas For Power Generation: Ethanol as an automobile fuel, Ethanol production & its use in engines.

UNIT – 4 **[12 hrs]**

Bio – Diesel: Sources, production of bio diesel from non edible oils, Blending of Bio diesel, Performance analysis of diesel engines using bio diesel. Effect of use of bio diesel in I C engines.

Bio Power Plants: Bio Power generation routes, Basic Thermodynamic cycles in Bio power generation; Brayton cycle, Sterling cycle, Rankine cycle, Co-generation cycle. Biomass based steam power plant.

Text Books

1. **Bio Gas Technology,** B.T. Nijaguna. New Age International- New Delhi.2001-02
2. **Energy Technology,** S. Rao & B. B. Parulekar – Khanna Publishers, Delhi-1999.
3. **Non Conventional Energy Sources,** G. D. Rai – Khanna Publishers. Delhi.

Reference Books

1. **Greenhouse Technology for Controlled Environment,** G.N. Tiwari, Alpha Science International Ltd., Pangbourne.England.
2. **Renewable Energy Resources,** John.W.Twidell, Anthony. D. Weir, EC BG-2001.
3. **BioMass,** Deglisc. X and P. Magne**,** Millennium Enterprise, New Delhi.

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F8320	**RAPID PROTOTYPING**	16	SC	4	0	0	4	4
Prerequisites: None		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To learn the fundamentals of Rapid prototyping and related concepts to understand the various materials used in the techniques.
2. To minimize sustaining engineering changes
3. To extent product life time by adding necessary features and eliminating redundant features early in the design.
4. To have a hands on experience on various tools used for modeling and manufacturing aspects of RP
5. To understand the role of rapid prototyping and rapid tooling.
6. To study about the programming aspects by using machine code languages for various operations using sophisticated software's (Manual and computer aided part programming)

Course outcomes:

After completion of the course the Students will be able to

1. Apply the various techniques in order to produce Prototypes, a pattern development for rapid tooling and various RP software.
2. To know the impact of Rapid prototyping, Rapid tooling and Rapid manufacturing in the product development process.

Course Content:

UNIT- 1 **[12 hrs]**

Introduction: Definition of RP, Prototypes, Types of prototypes, roles of prototypes, Need for the compression in product development, Impact of Rapid prototyping in product development, history

of RP systems, Survey of applications, industry and classification of RP systems, Basic methodology of RP, Benefits and limitations.

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.

UNIT -2 **[12 hrs]**

Solid Ground Curing: Principle of operation, Machine details, Applications

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications.

Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications.

Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.

UNIT -3 **[12 hrs]**

Concepts Modelers: Principle, Thermal jet printer, Sander's model maker, 3-D printer., object Quadra systems.

Rapid Tooling: Indirect Rapid tooling, Silicon rubber tooling, Aluminium filled epoxy tooling, Spray metal tooling, 3D keltool, etc. Direct Rapid Tooling, Quick cast process, Copper polyamide, Rapid Tool, DMILS, , Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.

Software for RP: STL files, Overview of Solid view, magic's, Mimics, magic communicator, etc. Internet based manufacturing.

UNIT -4 **[12 hrs]**

Rapid Manufacturing Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

Allied process: surface digitizing, Surface generation from point cloud data, surface modification – data transfer to solid models.

Detail application with respect to Aerospace, medical, and automobile industry.

Text Books:

1. **Stereo Lithography and other RP & M Technologies**, Paul F. Jacobs: SME, NY 1996.
2. **Rapid Manufacturing**, Pham D.T & Dimov, S.S Verlog London 2001

Reference Books:

1. **Rapid Prototyping**, Terry Wohlers Wohler's Report 2000" Wohler's Association 2000.
2. **Rapid Prototyping Materials**, Gurumurthi, IISc Bangalore
3. **Rapid Automated**, Lament wood. Indus press New York

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F8330	**NON DESTRUCTIVE TESTING METHODS**	16	SC	4	0	0	4	4
Prerequisites: None		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. Understand principle behind various NDT techniques and study about NDT equipments and accessories.
2. Learn working procedures of various NDT techniques
3. Learn materials that could be inspected – codes, standards, specifications.

Course Outcome:

After completion of the course **t**he students will be able to:

1. Use NDT equipments and accessories.
2. Use the NDT techniques in practical applications.
3. Compare and select of various NDT techniques based on the applications

Course Content:

UNIT-1 [**12 hrs]**

Non-Destructive Testing: Introduction to various non destructive methods- Comparison of Destructive and Non destructive Tests, Visual Inspection, Optical aids used for visual inspection, Applications.

UNIT-2 [**12 hrs]**

Liquid Penetrant Testing, Magnetic Particle Testing: Physical principles, procedure for penetrate testing, Penetrant Testing materials, Penetrant testing methods – water washable, post – Emulsifiable methods, Applications Principle of MPT, procedure used for testing a component , Equipment used for MPT, Applications

UNIT-3 [**12 hrs]**

Eddy Current Testing, Acoustic Emission

Principles, Instrumentation for ECT, Absolute – differential probes, Techniques – High sensitivity Techniques, Applications Principle of AET, Instrumentation, Applications – testing of metal pressure vessels, Fatigue crack detection in aerospace structures.

UNIT-4 [**12 hrs]**

Ultrasonic Testing: Principle , Ultrasonic transducers ,Inspection Methods, Normal Inscudent Pulse – Echo Inspection , Through – transmission Testing , angle Beam Pulse – Echo testing , Techniques for Normal Beam Inspection , Ultrasonic Flaw detection Equipment , Modes of display A- scan , B-Scan , C- Scan ,Applications.

Radiography , Comparison and selection of NDT methods

Basic principle, Effect of radiation on Film, Radiographic imaging , Inspection Techniques – Single wall single image , Double wall Penetration , Multiwall Penetration technique. Comparison and selection of various NDT techniques

Text Book:

1. Baldev raj, T Jeyakumar, M. Thavasimuthu **Practical Non Destructive Testing** Narosa publishing house, New Delhi, 2002

Reference Books:

1. Krautkramer. J., **Ultra Sonic Testing of Materials**, 1st Edition, Springer Verlag Publication, New York, 1996.
2. Peter J. Shull Non Destructive Evaluation: **Theory, Techniques and Application** Marcel Dekker, Inc., New York, 2002

Course Code	Course Title	Duration (Weeks)	Course Type	L	T	P	C	Hrs./ Wk.
BTME16F8340	**MACHINE TOOL DESIGN**	16	SC	4	0	0	4	4
Prerequisites: Manufacturing process		Internal Assessment			Semester End Exam			
		40 Marks			60 Marks			

Course Objectives:

1. To know the design consideration for the manufacturing and selection of tool.
2. To Know the tool life and there regulation when it is under operating condition.

Course Objectives:

After completion of the course the student will be able to

1. Describes the tool life and manufacturing of different tools.
2. Explains the regulation and general consideration for the selection of tool.
3. Work using computer software and simulation of tool.

Course Content:

UNIT – 1 **[12 hrs]**

Principles Of Machine Tool Design: General requirements of machine tool design – design process machine tool layout general requirements of machine tool design – design process machine tool layout.

Machine Tool Drives And Mechanisms: Working and auxiliary motion. Drives- Electric drives, Hydraulic transmission, Kinematic structure, Regulation of speed and feeds, stepped regulation, standardization of speed and feed, step less regulation of speeds and feeds.

UNIT – 2 **[12 hrs]**

Cutting Force Analysis And Power Requirement: In Turning, Milling, Drilling, Shaping and Broaching operation with simple problems. General requirements of machine tools – Centre lathe, Milling machine.

Design of Machine Tool Structures: Functions-Requirements-Design criteria Material used – static and dynamic stiffness – Profile and basic design procedure for machine tool structures. Design of beds, columns, housing, bases, tables, cross-rails, arms saddle, carriages.

UNIT – 3 **[12 hrs]**

Design Of Guide Ways And Power Screws: Function and types of guide ways – Design and lubrication of slide ways –antifriction guide ways, protecting devices, design of power screws.

Design Of Spindle And Spindle Bearings: Functions-Requirements and materials for spindle compliance and machining accuracy. Design of spindles, antifriction bearing, Hydrodynamic and Hydrostatic bearing, Air lubricated bearing.

UNIT – 4 **[12 hrs]**

Dynamics Of Machine Tools: Concept of dynamic cutting process, Physical causes of chatter and vibrations, Types of Chatter. Stability chart, chatter vibration in Lathe, Drilling machine, Grinding machine and Milling machine. Different methods for avoiding machine tool chatter and vibration.

Control Systems In Machine Tools: Functions, requirements and classification. Control system for speed and feeds centralized control pre selective control, control system for forming and auxiliary motions – Mechanical control– Ergonomic consideration and compatibility – Automatic control system – Electric Hydraulic and pneumatic systems.

Text Books

1. **Machine Tool Design,** N.K. Mehta, 2nd Ed., Tata McGraw Hill 2001
2. **Principles of Machine Tools,** Sen and Bhattacharaya Oxford IBM Publishing 2000

Reference Books

1. **Machine Tool Design Volume – II and III,** N. Acharkan MIR Publications 2000
2. **Design of Machine Tools**, S. K. Basu and D. K. Pal 2000
3. **Principles of Machine Tool Design**, Koensberger

Career Development and Placement

Having a degree will open doors to the world of opportunities for you. But Employers are looking for much more than just a degree. They want graduates who stand out from the crowd and exhibit real life skills that can be applied to their organizations. Examples of such popular skills employers look for include:

- Willingness to learn
- Self motivation
- Team work
- Communication skills and application of these skills to real scenarios
- Requirement of gathering, design and analysis, development and testing skills
- Analytical and Technical skills
- Computer skills
- Internet searching skills
- Information consolidation and presentation skills
- Role play
- Group discussion, and so on

REVA University therefore, has given utmost importance to develop these skills through variety of training programs and such other activities that induce the said skills among all students. A full-fledged Career Counseling and Placement division, namely Career Development Center (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counselors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students of REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidates for placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improve their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Commerce is efficient leaders of repute, who can deal the real time problems with a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, leadership, and strategic management and communication skills to every student of REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal skills that will fetch them a job of repute in the area of his / her interest and march forward to make better career.

The University has recognized skill development and industry relationship as its very important activities. Therefore, the University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director has been established to facilitate skill related training to REVA students and other unemployed students around REVA campus. The center conducts variety of skill development programs to students to suite to their career opportunities. Through this skill development centre the students shall compulsorily complete at least two skill / certification based programs before the completion of their degree. The University has collaborations with Industries, Corporate training organizations, research institutions and Government agencies like NSDC (National Skill Development Corporation) to conduct certification programs. REVA University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana.

The various skill/certification programs identified are as follows:

- Big-data and Cloud Computing, Internet of Things (IOT), ORACLE, MYSQL, Advanced Java and Internals of LINUX/UNIX
- Red-hat certified programs on LINUX,
- Management related programs like SAP,ERP and Business Analytics
- Open Source software/hardware, Software Testing
- Advanced networking based CISCO / Microsoft technology.
- Web designing, System administration
- IBM certified programs.

The University has signed MOU's with Multi-National Companies, research institutions, and universities abroad to facilitate greater opportunities of employability, students' exchange programs for higher learning and for conducting certification programs

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DO'S AND DON'TS

DO'S

1. Maintain discipline and respect the rules and regulations of the university
2. Be regular and punctual to classes
3. Study regularly and submit assignments on time
4. Be respectful to your Teaches/friends and hostel staff/management.
5. Read the notice board (both at your college and the hostel) regularly.
6. Utilize your Personal Computer for educational purpose only.
7. Follow the code of conduct.
8. Visit Health Center on the campus whenever you are unwell.
9. Be security conscious and take care of your valuables especially Cash, Mobile Phones, Laptop and other valuables.
10. Carry your valuables along with you whenever you proceed on leave/vacation.
11. Use electric appliances, lights and water optimally.
12. Keep the campus clean and hygienic.
13. Use decent dressing.

DON'TS

1. Ragging inside / outside the campus.
2. Possession of Fire arms and daggers etc.
3. Use of Alcohols, Toxic drugs, sheesha, gutkha and hashish/heroin etc.
4. Use of Crackers, explosives and ammunition etc.
5. Smoking and keeping any kind of such items.
6. Misusing college & hostel premises/facilities for activities other than studies.
7. Playing loud music in the room which may disturb studies of colleagues / neighbours.
8. Making noise and raising slogans.
9. Keeping electrical appliances, other than authorized ones.
10. Involvement in politics, ethnic, sectarian and other undesirable activities.
11. Proxy in any manner.
12. Use of mobiles in the academic areas.

Note: 1. Rules are revised / reviewed as and when required.

2. Healthy suggestions are welcome for betterment of Institution