SCHOOL OF APPLIED SCIENCES

M Sc. in Mathematics Program

HAND BOOK
2017-19

Rukmini Knowledge Park,
Kattigenahalli, Yelahanka, Bangalore-560064
Phone No: +91-080-66226622, Fax: 080-28478539

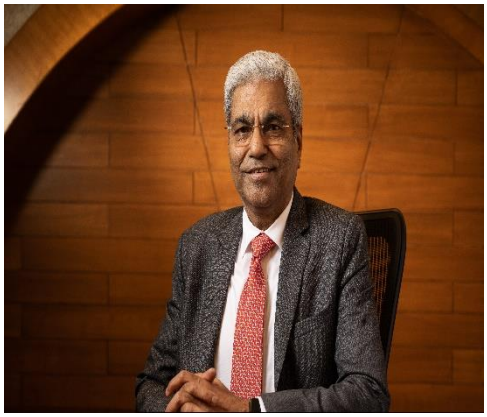
Rukmini Educational
Charitable Trust

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 ahuge 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. 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

Director's Message

The M.Sc. Mathematics programme aims to build strong foundations in core areas of higher mathematics in both the pure and applied areas. It is meant for students who would typically take up careers involving mathematical research or mathematical skills – in academia or in industry. The training imparted to the students helps them master the art of problem solving, developing logical reasoning and computational capabilities which are essential traits in all walks of life. Additionally, the knowledge of mathematical modelling and computational training which the students acquire during the programme makes them highly sought after. In keeping with the demands of industry and academia, the syllabus is updated regularly, with inputs taken from various stakeholders including students, alumni, and parents at different stages of the preparation of the syllabus. The curriculum is carefully designed to meet the NET and GATE examination syllabus and industry trends. Curriculum has good mix of foundation courses, hardcore courses, soft-core courses, practical's, and projects along with open electives, soft skill and skill development courses.

The curriculum caters to and has relevance to local regional, national and global developmental needs. Maximum number of courses are integrated with crosscutting issues with relevant to professional ethics, Gender, Human values, Environment and sustainability.

Since the beginning of REVA University, the Mathematics Department is involved in implementing best practices in various dimensions such as academics, research, outreach activities, student development programs, student centric learning, student competitions, skill enhancement activities, motivation for competitive exams, mini projects, major projects, multidisciplinary projects, industry visits, technical talks by industry and academicians, certification programs, etc. Individual students are taken care by a strong mentoring system wherein faculty members are not only allotted as mentors to students, but also they will act as local guardians and they will have constant follow up with mentees in regard to academic and personal issues till students complete the degree.

This handbook provides an outline of regulations for master's degree, scheme of instruction, and detailed syllabus. I am sure the students choosing MSc Mathematics at REVA University will enjoy the curriculum, teaching and learning environment, the vast infrastructure and the experienced teachers' involvement and guidance. We will strive to provide all needed comfort and congenial environment for their studies. I wish all students a pleasant stay at REVA and grand success in their career.

Dr. Beena G

Director
School of Applied Sciences

PREFACE

Higher education across the globe is opening doors of its academic disciplines to the real-world experiences. The disciplinary legitimacy is under critical review. Trans-border mobility and practice learning are being fore-grounded as guiding principles. Interactive learning, bridging disciplines and facilitating learners to gain different competencies through judicious management of time is viewed as one of the greatest and fascinating priorities and challenges today.

The M.Sc. Mathematics is designed keeping in view the current situation and possible future developments, both at national and global levels. This course is designed to give greater emphasis on Research. There are ample number of courses providing knowledge in specialized areas of Abstract Algebra, Linear Algebra, Real and Complex Analysis, Topology, Functional Analysis, Number theory, computational techniques, R-tools, and Python etc. facilitating students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts of analysis and modern computation techniques to be used and knowledge on application of such concepts in practical field. The project, being part of the curriculum will certainly provide students the experience of practical exposure in working environment.

The L: T: P structure of teaching and learning under Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) would certainly help our students learn and build competencies needed in this knowledge based society.

This handy document containing a brief information about M.Sc. Mathematics, scheme of instruction, course content, CBCS-CAGP regulations and its advantages and calendar of events for the year will serve as a guiding path to students to move forward in a right direction. It would mould them with knowledge, skill and ethical values to face the challenges of this competitive world with greater confidence in becoming proud citizens of mother India.

CONTENTS

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 11,000 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 recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. The Centre conducts several

add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

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

The University has also given greater importance to quality in education, research, administration, and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing, and developing different quality tools, implementing them, and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

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

Vision

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

Mission

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

Objectives

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

ABOUT THE SCHOOL OF APPLIED SCIENCES

The School of Applied Sciences offers graduate and post graduate programs in Biotechnology, Biochemistry, Chemistry, Physics and Mathematics which are incredibly fascinating. It aims to attract talented youth and train them to acquire knowledge and skills useful to industrial sectors, research laboratories, and educational institutions. The School presently offers M.Sc. degree programs in Bio-Chemistry, Bio-Technology, Chemistry, Physics, Mathematics and B Sc with various combinations viz, Physics Chemistry and Mathematics, Mathematics , Physics and Statistics, Mathematics Statistics and Computer Science, and Biology Mathematics & Computer Science and also Post Graduate Diploma in Clinical Research Management. The School also facilitates research leading to PhD in Biotechnology, Biochemistry, Physics, Chemistry, Mathematics, and related areas of study.

The School of Applied Sciences is shouldered by well qualified, experienced, and highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equipped laboratories, conference rooms and the serene academic atmosphere at REVA University will enhance the transfer as well as creation of knowledge. The school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school aims to develop a learning community of critical thinkers who serves as models of innovative problems solving in the university environment to enrich their academic and professional careers.

Vision

To nurture intellect, creativity, character, and professionalism among students and impart contemporary knowledge in various branches of Chemical, Biological, Physical and Mathematical Sciences that are socially relevant and transform them to become global citizens.

Mission

To achieve excellence in studies and research through pedagogy and support interface between industry and academia.

About the Department of Mathematics

The school of Physical Sciences headed by a highly experienced professor and is supported by a highly experienced and well qualified faculty. The school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school will develop a learning community of critical thinkers who serves as models of innovative problems solving in the university environment to enrich their professional careers. M.Sc., in Mathematics is designed to meet the present-day demand for specific mathematical and computational skills and training requirements of science, engineering, and technology graduates. The courses are tailored to prepare students in teaching and research as well as in community activities and development. The courses provide opportunity for the students to know about the applications of mathematics in several fields of practical interest including those of designing & writing codes and computer algorithms for dealing with various systems. The areas of study that covers analysis, algebra, topology, complex analysis, differential equations, mechanics, discrete mathematics, Statistics, programming language, design & analysis of algorithms, theory of computation, and numerical techniques. Besides, greater emphasis is laid on methods of Mathematics, fluid mechanics, mathematical modeling and simulation, graph theory, fuzzy logic, cryptography, operations research, and mathematics of multimedia.

The minor project work that the students must undertake compulsorily is integrated with industry experience. This will not only enhance acquaintance to applications of mathematics, computation and their models to real world problems but improve students' knowledge and self-confidence. The school also has research program leading to doctoral degree. The curriculum of both graduate and post-graduate degree programs have been designed to bridge the gap between academia-research. The program focus on research to offer professional services at National and International levels

Advisory Board

Proceedings of the meeting of the Board of Studies in Mathematics held on 1st June, 2017 at 10.30 am in the Department of Mathematics, Conference Hall, Admin Block, REVA University, Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru-560064.

REVA UNIVERSITY
Bengaluru, India

Board of Studies in Mathematics

Date of the Meeting: 01.06.2017 **Time: 10.30 AM**

Sl. No.	Name of Members	Designation	Signature
1	Dr. Hanumagowda B N Professor, School of Basic Sciences – Mathematics, RU	Chairperson	
2	**Prof. A.S.Vasudeva Murthy,** Associate Professor, TIFR-CIM, Yelahanka Bangalore, Email ID: ma28@vsnl.net	Member	
3	**Dr. Joseph Varghese,** Associate Professor, Department of Mathematics Christ University, Bangalore 560029, Email: frjoseph@christuniversity.in	Member	
4	**Mr. Sandeepa M. S.** Data Scientist, Assistant Manager DXC Technologies, Electronic City, Bangalore	Member	M.S.
5	**Dr. Vishu Kumar** Professor, School of Basic Sciences, REVA University, Bangalore	Member	M. Vishwanath
6	**Dr. Harish Babu G A** Professor, School of Basic Sciences, REVA University, Bangalore	Member	
7	**Dr. Murugesan R** Professor, School of Basic Sciences, REVA University, Bangalore	Member	
8	**Dr. Nagamaruthi Kumari** Associate Professor, School of Basic Sciences, REVA University,	Invitee	
9	**Dr.Raju B. T.** Associate Professor, School of Basic Sciences, REVA University,	Invitee	
10	**Dr. Uday Kumar K.N.** Associate Professor, School of Basic Sciences, REVA University,	Invitee	
11	**Ms. Brinda Halambi** Asst. Professor, School of Mathematics, REVA University, Bangalore	Invitee	

Proceedings

At the outset, Prof. Hanumagowda, the Chairperson of the BoS in Department Of Mathematics welcomed all the members present, explained the purpose of the meeting and the agenda in brief. Then the agenda was taken up for discussion, when Dr.R.Murugesan has given the Power Point Presentation.

Agenda 1: Preparation of Course Curriculum.

The Chairperson explained briefly about the establishment of REVA University and the course being introduced under REVA University. He also explained the features of CBCS/CAGP of education the University is committed to follow since its inception itself. He requested all the members to corporate and to draft the curriculum as per the REVA University Regulations for CBCS-CAGP for PG programs.

The BoS members discussed the agenda in detail and drafted the course curriculum including the scheme of instruction, eligibility criterion, etc. The Board also drafted detailed syllabus.

Resolution: The Board unanimously resolved to adopt CBCS-CAGP of education for M.sc in Mathematics program from the Academic Year 2017-19 and recommend the University to adopt detailed curriculum drafted, which is provided in Annexure 2.

M.Sc., (Mathematics) Program

Program Overview

The mathematical sciences are a group of areas of study that includes, in addition to mathematics, those academic disciplines that are primarily mathematical in nature but may not be universally considered subfields of mathematics proper. Statistics, for example, is mathematical in its methods but grew out of scientific observations which merged with inverse probability and grew through applications in the social sciences.

Mathematical sciences work is becoming an increasingly integral and essential component of a growing array of areas of investigation in biology, medicine, social sciences, business, advanced design, climate, finance, advanced materials, and much more. This work involves the integration of mathematics, statistics, and computation in the broadest sense, and the interplay of these areas with areas of potential application; the mathematical sciences are best conceived of as including all these components. These activities are crucial to economic growth, national competitiveness, and national security.

Thus, mathematics is an essential part of the educational system of an advanced society. Indian Society has embraced knowledge economy and its economic growth rate is one of the highest in the world. India has shown highest level of progress in engineering, space, nuclear, aeronautics and information and communication technologies. The subject of mathematics has played a major role in the development of country and Manjul Bhargava is a Canadian-American mathematician of Indian origins has won Field Medal which is equivalent to Nobel Prize in mathematics.

In this context, Universities across the country offer Mathematics as a subject at undergraduate and Mathematics as a programme at postgraduate level.

M. Sc. (Mathematics) at REVA UNIVERSITY has been designed to meet the human resources needs of existing and futuristic research establishments, industries and academic institutions. The programme is designed to produce graduates with higher order critical, analytical, problem solving and research skills; ability to think rigorously and independently to meet higher level expectations of industries, research organization and academic institutions.

The programme deals with analysis, algebra, topology, complex analysis, differential equations, discrete mathematics, mechanics and numerical analysis. Besides, greater emphasis is laid on methods of mathematics, fluid mechanics, mathematical modeling, graph theory, fuzzy logic, cryptography, operation research and mathematics of multimedia.

Program Educational Objectives (PEOs)

The program educational objectives of the Mathematics of REVA University are to prepare the graduates to

PEO-1	Serve as a tutor in mathematics and perform with effective communication and ethics.
PEO-2	Carryout research in the areas of pure and applied mathematics and publish work as individual or in a team.
PEO-3	Provide consultancy in the advanced areas of mathematics with lifelong learning attitude.

Program Outcomes (POs):

PO-1	**Science knowledge**: Demonstrate the skills in the areas of mathematics and applied areas.
PO-2	**Problem analysis**: Apply mathematical skills to formulate, solve and interpret complex problems through mathematical models.
PO-3	**Conduct investigations of complex problems**: Comprehend, analyze, model, and solve complex problems based on structured and relevant reasoning.
PO-4	**Modern tool usage:** Use latest computer techniques as a tool to carry out scientific investigations and develop new variants of the acquired methods and problems related to environment and society.
PO-5	**Ethics:** Exhibit professional and ethical responsibility.
PO-6	**Individual and teamwork**: Encourage collaborative learning through group activities and hands-on learning.
PO-7	**Communication**: Communicate mathematical ideas with clarity and coherence, both written and verbally.
PO-8	**Life-long learning**: Recognize the need to expertise in the areas of mathematics by self-up gradation through lifelong learning.

Program Specific Outcomes (PSO)

After successful completion of the programme, the graduates shall be able to

PSO-1	Demonstrate the knowledge of Mathematical Analysis, Algebra, Statistics, Optimization and Computational Mathematics.
PSO-2	Analyse and solve problems in Mathematical Analysis, Algebra, Statistics, Optimization and Computational Mathematics.
PSO-3	Use tools and techniques for addressing the problems of Industry, Organizations, and environment in Mathematical Analysis, Algebra, Statistics, Optimization and Computational Mathematics.

Mapping of PEOS with Respect to POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
PEO1	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√

Attainment of CO (Course Outcome)

CO Attainment	Value
0.4 - 0.6	1
0.6 – 0.75	2
> 0.75	3

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT101	CO1	3	2	2		3		1	3	3	3
	CO2	3	3	2		2		1	2	3	3
	CO3	3	3	2		3		1	1	3	3
	CO4	3	3	2		2		1	2	3	3
MS17MT102	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	3	1		2	2	1	1	3	3
	CO2	3	2	1		2	1	2	1	3	3
	CO3	3	2	1		2	2	2	1	3	3
	CO4	3	2	1		2	2	2	1	3	3
MS17MT103	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	3	1	2	2	3	2	3	3	3
	CO2	3	2	1	1	1	2	2	3	3	3
	CO3	3	2	1		2	2	1	3	3	3
	CO4	3	2	1	1	2	2	1	3	3	3
	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	1	1		1	2	3	3
	CO2	3	2	2	1	1		1	2	3	3

	CO3	3	2	2	1	1		1	2	3	3
	CO4	3	2	2	1			1	3	3	3
MS17MT115	POS/ COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	3	1		2	1	2	2	3	3
	CO2	3	2	1		1		3	3	3	3
	CO3	3	2	1		1		3	3	3	3
	CO4	3	2	1		1		2	2	3	3
MS17MT125	POS/ Cos	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	3	1	2	2	2	3	3	3	3
	CO2	3	2	1	2	2	2	3	3	3	3
	CO3	3	2	1	1	2	1	3	3	3	3
	CO4	3	2	1		1		2	2	3	3
MS17MT106	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	1	1			1		3	3
	CO2	3	2	1	1			1		3	3
	CO3	3	2	1	1		1		1	3	3
	CO4	3	2	2		1		1	2	3	3
MS17MT201	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	1	2	1			2	3	3
	CO2	3	2	1	2	1		1	1	3	3
	CO3	3	2	1	1			1	2	3	3
	CO4	3	2	1	2	1		1	3	3	3
MS17MT202	POS/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2

	COs										
	CO1	3	2	1		1		1	1	3	3
	CO2	3	2	2	1			1	2	3	3
	CO3	3	1	2	1	1		1	1	3	3
	CO4	3	2	1	1			1	1	3	3
MS17MT203	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	1	1		1	2	3	3
	CO2	3	2	2	1	1		1	2	3	3
	CO3	3	2	2	1	1		1	2	3	3
	CO4	3	2	2	1			1	3	3	3
MS17MT204	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2		1	1	1	2	3	3
	CO2	3	2	1		1		1	2	3	3
	CO3	3	1	2	1	1		1	2	3	3
	CO4	3	2	2	1				2	3	3
MS17MT215	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	3	1		1		1	2	3	3
	CO2	3	2	1		1		2	2	3	3
	CO3	3	2	1		1		2	1	3	3
	CO4	3	2	1		2		2	3	3	3
MS17MT225	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	1		1		1		3	3

	CO2	3	2	2		2		1		3	3
	CO3	3	2	2		1		1		3	3
	CO4	3	2	2		1		1		3	3
MS17MT216	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	1		1			3	3	3
	CO2	3	2	1		1			3	3	3
	CO3	3	2	2		1			3	3	3
	CO4	3	2	1		1			3	3	3
MS17MT226	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	1		1			3	3	3
	CO2	3	2	1		1			3	3	3
	CO3	3	2	2		1			3	3	3
	CO4	3	2	1		1			3	3	3
MS17MT301	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	1	1	2		1		3	3
	CO2	3	2	2	1	2		1		3	3
	CO3	3	2	1		1		1		3	3
	CO4	3	1	2		1		1		3	3
MS17MT302	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	3	2	2		3	2	3	3
	CO2	3	2	3	2	1		2	1	3	3
	CO3	3	2	3	2	2		3		3	3

	CO4	3	2	3	2	1		2	1	3	3
MS17MT303	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	2			1	1	3	3
	CO2	3	1	1	2	2		1	2	3	3
	CO3	3	2	1	2	1		2	2	3	3
	CO4	3	2	1	2	1		1	2	3	3
MS17MT314	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	3	2	2		2	2	3	3
	CO2	3	2	3	2	1		2	2	3	3
	CO3	3	3	2	2	1		2	1	3	3
	CO4	3	3	2	2	1		1	2	3	3
MS17MT324	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	2			1	1	3	3
	CO2	3	1	1	2	2		1	2	3	3
	CO3	3	2	1	2	1		2	2	3	3
	CO4	3	2	1	2	1		1	2	3	3
MS17MT305	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	1		1		2	2	3	3
	CO2	3	2	1	1	1		2	2	3	3
	CO3	3	2	1	2	1		1	2	3	3
	CO4	3	2	1	2	1		2	1	3	3
MS17MT411	POS/	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2

	COs										
	CO1	3	2	2	1			1	1	3	3
	CO2	3	2	1	1	1			1	3	3
	CO3	3	2	2		2		1	1	3	3
	CO4	3	1	1	2			1	1	3	3
MS17MT421	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	1	2	1	2		2	2	3	3
	CO2	3	1	2	2	1		1	2	3	3
	CO3	3	2	2	1	1		2	2	3	3
	CO4	3	2	2	1	1		2	2	3	3
MS17MT402	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	2	1	1		1	3	3
	CO2	3	1	2	1	2	1		1	3	3
	CO3	3	2	2	1	2		1	1	3	3
	CO4	3	1	2	1	1		2	1	3	3
MS17MT403	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	1	2	2	1		1	1	3	3
	CO2	3	2	1	2	2		2	2	3	3
	CO3	3	2	2	2	2		1	2	3	3
	CO4	3	2	1	2	2		1	2	3	3
MS17MT414	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	1	2		1	2	3	3

	CO2	3	2	2	1	1		1	2	3	3
	CO3	3	2	1	2	1		1	2	3	3
	CO4	3	2	2	1	2		2	2	3	3
MS17MT424	POS/ COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	1	1	1	1	1	3	3
	CO2	3	2	1			1			3	3
	CO3	3	2	2	1	2		2	1	3	3
	CO4	3	2	2	2	1	1	1	2	3	3
MS17MT405	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	1	1	1	1	1	3	3
	CO2	3	2	2	1	2		1	1	3	3
	CO3	3	2	2	1	1	1	1	1	3	3
	CO4	3	2	1	2	1	1	1	1	3	3
MS17MT416	POS/ COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	1	1	1	1	1	3	3
	CO2	3	2	1			1			3	3
	CO3	3	2	2	1	2		2	1	3	3
	CO4	3	2	2	2	1	1	1	2	3	3
MS17MT426	POS/ COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	1	1	1	1	1	3	3
	CO2	3	2	1			1			3	3
	CO3	3	2	2	1	2		2	1	3	3
	CO4	3	2	2	2	1	1	1	2	3	3
MS17MT307	POS/ COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	3	2	1	1	1	1	1	3	3

	CO2	3	2	1			1			3	2
	CO3	3	3	2	1	2		2	1	3	2
	CO4	3	2	2	2	1	1	1	2	3	3
MS17MT308	POS/ COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
	CO1	3	2	2	1	1	1	1	1	3	2
	CO2	3	2	1			1			3	3
	CO3	3	3	2	1	1		2	1	3	2
	CO4	3	2	2	2	1	1	1	2	3	3

REVA University Regulations for CBCS (CHOICE BASED CREDIT SYSTEM) AND CAGP (CONTINUOUS ASSESSMENT AND GRADING PATTERN) OF EDUCATION AND ITS ADVANTAGES

CBCS is a proven, advanced mode of learning in higher education. It facilitates students to have freedom in making their own choices for acquiring a Degree / Master's Degree program. It is more focused towards the student's choice in providing a wide range of Units available in a single campus across various disciplines offered by experts in the subjects. It leads to quality education with active teacher-student participation.

Studying under CBCS has following advantages:

- Students may undergo training in cross-disciplinary and multi-disciplinary subjects and acquire more focused and preferred knowledge.
- Students may get more skills from other subject(s) which are required for the career path in addition to their regular subject knowledge.
- Students may get many opportunities to use the laboratories and gain practical exposure to the much-needed Units available in other departments/schools for want of scientific inputs.
- Courses are conducted by subject experts identified based on their experiences. Courses taught by such experts may provide in-depth information and clear understanding of the Units.
- Students may get an opportunity to study courses with other students of different programs and exchange their views and knowledge in a common class room.
- CBCS provides a cross-cultural learning environment.
- Students may benefit much from selecting the right options to successfully face the public service examinations like UPSC, KPSC, IES wherein the knowledge of additional subjects become mandatory for general or optional papers.
- Students are exposed to the culture of universal brotherhood during their campus life.
- Students can practice various methods of learning a subject.

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

CBCS is a proven, advanced mode of learning in higher education. It facilitates students to have freedom in making their own choices for acquiring a Degree / Master Degree program. It is more focused towards the student's choice in providing a wide range of modules available in a single campus across various disciplines offered by experts in the subjects. It leads to quality education with active teacher-student participation.

Studying under CBCS has following advantages:

- Students may undergo training in cross-disciplinary and multi-disciplinary subjects and acquire more focused and preferred knowledge.
- Students may get more skills from other subject(s) which are required for the career path in addition to their regular subject knowledge.
- Students may get many opportunities to use the laboratories and gain practical exposure to the much-needed modules available in other departments/schools for want of scientific inputs.
- Courses are conducted by subject experts identified based on their experiences. Courses taught by such experts may provide in-depth information and clear understanding of the modules.
- Students may get an opportunity to study courses with other students of different programs and exchange their views and knowledge in a common class room.
- CBCS provides a cross-cultural learning environment.
- Students may benefit much from selecting the right options to successfully face the public service examinations like UPSC, KPSC, IES wherein the knowledge of additional subjects become mandatory for general or optional papers.
- Students are exposed to the culture of universal brotherhood during their campus life.
- Students can practice various methods of learning a subject.

BRIEF OUTLINE OF REVA UNIVERSITY REGULATIONS FOR CHOICE BASED CREDIT SYSTEM (CBCS) AND CONTINUOUS ASSESSMENT GRADING PATTERN (CAGP) FOR M.Sc. PROGRAM IN MATHEMATICS, 2017

Course:

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

(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.

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, over a period of one Semester of 16 weeks for teaching-learning process. The total duration of a semester is 20 weeks inclusive of semester-end examination.

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

The total credits earned by a student at the end of the semester upon successfully completing the course are L + T + P. The credit pattern of the course is indicated as L: T: P.

If a course is of 4 credits then the different credit distribution patterns in L: T: P format could be:

4 : 0 : 0, 1 : 2 : 1, 1 : 1 : 2, 1 : 0 : 3, 1 : 3 : 0,

2 : 1 : 1, 2 : 2 : 0, 2 : 0 : 2, 3 : 1 : 0, 3 : 0 : 1,

0 : 2 : 2, 0 : 4 : 0, 0 : 0 : 4, 0 : 1 : 3, 0 : 3 : 1,

The concerned BoS will choose the convenient Credit Pattern for every course based on the requirement. However, generally, a course shall be of FOUR Credits and occasionally may be of TWO Credits.

Different Courses of Study are labeled and defined as follows:

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.

(i) 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.

(ii) 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.

(iii) 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.

Open Elective Course:

An elective course chosen generally from other discipline / subject, with an intention to seek exposure is called an Open Elective Course.

Project Work:

Project work is a special course involving application of knowledge in solving / analyzing /exploring a real-life situation / difficult problem. A project works up to FOUR credits is called Minor Project work. A project work of EIGHT or TWELVE credits is called Major Project work. A Minor Project work may be a hard core or a Soft Core as decided by the BoS / School Council concerned. But the Major Project shall be Hard Core.

Eligibility for Admission:

The eligibility criteria for admission to Master Program of 2years (4 Semesters) are given below:

Sl. No.	Program	Duration	Eligibility
1	Master of Science (Mathematics)	2 Years	Passed Bachelor's Degree of 3 years with Mathematics as major / optional subject with 45% marks (40% in case of candidate belonging to SC/ST category) of marks in aggregate of any recognized / institution or any other qualification recognized as equivalent there to.

Duration of the program and Medium of Instruction:

A Master's degree program is of 4 semesters - 2 years duration of 96 credits. A candidate can avail a maximum of 8 semesters - 4 years as per double duration norm, in one stretch to complete Master's degree, including blank semesters, if any. Whenever a candidate opts for blank semesters, he/she has to study the prevailing courses offered by the School/Department when he/she resumes his/her studies.

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

A candidate can enroll for a maximum of 24 credits per Semester including:

(i) Dropped Courses of corresponding semester(s) of previous year(s), if any:

(ii) Additional Courses from the corresponding Semester of immediate succeeding year.

However, a candidate may not successfully earn a maximum of 24 credits per semester.

Generally, a full-time candidate may register for 20 credits per semester.

Eligibility for Declaration of Ranks / Medals:

Only such candidates who register for a minimum of 16 credits per semester from I semester to IV semester and complete successfully 96 credits in 4 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.

Continuous Assessment, Earning of Credits, and Award of Grades.

The assessment / evaluation of the candidate is based on continuous assessment. The structure for evaluation is as follows:

For assessment and evaluation, a semester is divided into 4 discrete components identified as IA1, IA2, and IA3 and Final

The performance of a candidate in a course will be assessed for a maximum of 100 marks as explained below. Scheme of Assessment & Evaluation

1. The Scheme of Assessment and Evaluation will have two parts, namely;
    i. Internal Assessment (IA); and
    ii. Semester End Examination (SEE)

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

3. The 50 marks of Internal Assessment (IA) shall comprise of:

Internal Test	= 30 marks
Assignments	= 10 marks
Seminars	= 10 marks

4. There shall be **three internal tests** conducted as per the schedule given below. T**he students must attend all the three tests compulsorily.**

- **1st test** for 15 marks during **the 6th week** of the beginning of the Semester;
- **2nd test** for 15 marks during **the 13th week** of the beginning of the Semester; and
- **3rd test** for 15 marks during **the 16th week** of the beginning of the Semester.

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

- For the **1st test** the syllabus shall be **First Unit and 1st half of Second Unit** of the Course;
- For the **2nd test** it shall be **Second half of Second Unit and Third Unit** of the Course;
- For the **3rd test** the syllabus will be **Fourth Unit** of the Course.

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

7. There shall be two Assignments and two Seminars each carrying 5 marks. Hence two assignments carry 10 marks (5+5 marks) and two seminars carry 10 marks (5+5 marks) as stated at Sl.No.3 above.

8. The Semester End Examination for 50 marks shall be held during 19th and 20th week of the beginning of the semester and **the syllabus for the semester end examination shall be entire 4 units**.

9. The **duration of the internal test shall be 90 minutes and for semester end examination the duration shall be 3 hours.**

10. The question papers for internal test shall be set by the internal faculty who have taught the course. If more than one faculty teaches the course all the faculty together shall devise the question paper(s). However, a Committee of senior faculty shall scrutinize these question papers to bring in the uniformity in the question paper pattern and as well to maintain the quality of the question papers.

11. The test shall be common for all the students and the evaluation of the answer scripts shall be done by the internal faculty who have taught the course.

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

13. There shall be double evaluation, viz, first valuation by the internal faculty who have taught the subject and second evaluation shall be the external examiner.

14. The average of the two evaluations (internal examiner & external examiner) shall be the marks to be considered for declaration of results.

Summary of Continuous 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	Second Part of 6th Week	First Unit and 1st half of Second Unit	15	Consolidation of First Unit and 1st half of Second Unit
Submission of Assignments	8th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Seminars	9th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Second Internal Test	2nd Part of 13th Week	2nd half of Second Unit and Third Unit	15	Consolidation of 2nd half of Second Unit and Third Unit
Allocation of Topic for 2nd Assignment / Seminars	11th Week	Third Unit and Fourth Unit		Instructional process and Continuous Assessment
Submission of Assignments	13th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Seminars	14th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Third Internal Test	2nd Part of 16th Week	Fourth Unit	15	Consolidation of entire Fourth Unit
Semester End Practical Examination	17th & 18th Week	Entire syllabus	50	Conduct of Semester - end Practical Exams
Preparation for Semester–End Exam	17th & 18th Week	Entire Syllabus		Revision and preparation for semester–end exam
Semester End Theory Examination	19th and 20th Week	Entire Syllabus	50	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.

14. Assessment of Performance in Practical's

14.1. The performance in the practice tasks / experiments shall be assessed based on:

a) Knowledge of relevant processes;

b) Skills and operations involved;

c) Results / products including calculation and reporting

14.2. The 50 marks meant for continuous assessment of the performance in carrying out practicals shall further be allocated as under:

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

14.3. The 50 marks meant for Semester End (C3) Examination, shall be allocated as under:

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

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

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

Right from the initial stage of defining the problem, the candidate must 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 must submit final report of the project / dissertation for final evaluation. The components of evaluation are as follows:

i	Periodic Progress and Progress Reports (25%)
ii	Results of Work and Draft Report (25%)
iii	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%.

16.0 Requirements to Pass a Course

16.1 A candidate's performance from IA and SEE will be in terms of scores, and the sum of IA and SEE scores will be for a maximum of 100 marks (IA = 50 + SEE = 50) and must secure a minimum of 40% to declare pass in the course. However, a candidate must secure a minimum of 25% (12.5 marks) in Semester End Examination (SEE) which is compulsory

16.2. **Eligibility to Appear for Semester - end Examination and Provision to Drop the Course.**

Only those students who fulfill 75% of attendance requirement are eligible to appear for Semester end examination in that course.

16.3. In case a candidate opts to drop the course he / she must re-register for the dropped course only in subsequent semesters whenever it is offered if it is Hard Core Course. He / she may choose alternative course if it is Soft Core Course or Open Elective course or Skill Development Course. **The details of any dropped course will not appear in the Grade Card.**

16.4. **Provision to Withdraw Course:**

A candidate can withdraw any course within ten days from the date of notification of final results. Whenever a candidate withdraws a course, he/she has to register for the same course in case it is hard core course, the same course or an alternate course if it is soft core/open elective. **A DROPPED course is automatically considered as a course withdrawn.**

17. Re-Registration and Re-Admission:

17.1 **Re-Registration and Re-Admission:** A candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University and is considered as dropped the semester and is not allowed to appear for end semester end examination (SEE shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

In case a candidate fails in more than 2 courses in odd and even semesters together in a given academic year, he / she may either drop all the courses and repeat the semester or reappear (SEE-semester end examination) to such of those courses where in the candidate has failed during subsequent semester / year within a stipulated period.

17.2 In such a case where in a candidate drops all the courses in 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.

17.3 **Requirements to Pass the Semester and Provision to Carry Forward the Failed Subjects / Courses:**

17.4 Provision to Carry Forward the Failed Subjects / Courses:

A student who has failed in 2 courses in 1st and 2nd semesters together shall move to 3rd semester. And he / she shall appear for semester end examination of failed courses of the said semesters concurrently with 3rd semester end examinations (SEE) and 4th semester end examinations (SEE)

of second year of study.

18. Attendance Requirement:

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

18.2 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.

18.3 Any student with less than 75% of attendance in a course in aggregate during a semester shall not be permitted to appear to the end semester (SEE) examination.

18.4 Faculty offering the courses will place the above details in the School / Department meeting during the last Wk. of the semester, before the commencement of SEE, and subsequently a notification pertaining to the above will be brought out by the Head of the School before the commencement of SEE examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

18.5 **Absence during mid semester examination**

In case a student has been absent from a mid-semester examination 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 make-up examination. 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 permit such student to appear for make-up mid semester examination.

18.6 **Absence during end semester examination:**

In case a student is absent for end semester examination on medical grounds or such other exigencies, the student can submit request for make-up examination, with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the School. The Director of the School may consider such request depending on the merit of the case and after consultation with class teacher, course instructor and permit such student to appear for make-up mid semester examination

19. **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).This statement will not contain the list of DROPPED courses.

19.1 **Challenge Valuation:**

A student who desires to apply for challenge valuation shall obtain a Xerox copy of the answer script 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 15 days after the announcement of the results. This challenge valuation is only for Semester End Examination (SEE) component.**The answer scripts for which challenge valuation is sought for shall be sent to another external examiner. The marks awarded will be the higher of the marks obtained in the challenge valuation and in maiden valuation.**

19.2 Final Grade Card: Upon successful completion of the Post Graduate Degree a Final Grade card consisting of grades of all courses successfully completed by the candidate will be issued by the Registrar (Evaluation).

19.3 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
80-89	9	v*9	A
70-79	8	v*8	B
60-69	7	v*7	C
50-59	6	v*6	D
40-49	5	v*5	E
0-39	0	v*0	F

O - Outstanding; A-Excellent; B-Very Good; C-Good; D-Fair; E-Satisfactory; F - Fail;

Here, P is the percentage of marks (P=[(IA1+IA2)+M] 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.

19.4 **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, i.e**., SGPA (Si) = ∑(Ci x Gi) / ∑Ci**

Where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} 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**	**B**	**8**	**4X8=32**
Course 3	**4**	**C**	**7**	**4X7=28**
Course 4	**4**	**O**	**10**	**4X10=40**
Course 5	**4**	**D**	**6**	**4X6=24**
Course 6	**4**	**O**	**10**	**4X10=40**
	24			**200**

Thus, **SGPA = 200 ÷ 24 = 8.33**

Illustration No. 2

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	**5**	**A**	**9**	**5X9=45**
Course 2	**5**	**C**	**7**	**5X7=35**
Course 3	**5**	**A**	**9**	**5X9=45**
Course 4	**5**	**B**	**8**	**5X8=40**
Course 5	**4**	**O**	**10**	**4X10=40**
	24			**205**

Thus, **SGPA = 205 ÷ 24 = 8.54**

19.5 Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (96) for two-year post graduate degree in Computer Science & Engineering 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 i^{th} 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	8.33	24 x 8.33 = 199.92
2	24	8.54	24 x 8.54 =204.96
3	24	9.35	24x9.35=224.4
4	24	9.50	24x9.50=228.0
Cumulative	96		857.28

Thus, **CGPA** = $\frac{24x8.33+24x8.54+24x9.35+24x9.50}{}$ = 8.93

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 8.93 x 10=89.30

19.6 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	Numerical Index	FGP
		Qualitative Index
> 4 CGPA < 5	**5**	SECOND CLASS
5 > = CGPA < 6	6	
6 >= CGPA < 7	7	FIRST CLASS
7 >= CGPA < 8	8	
8 >= CGPA < 9	9	DISTINCTION
9 >= CGPA 10	10	

Overall percentage=10*CGPA

20.0. Provision for Appeal

If a candidate is not satisfied with the evaluation of IA1, IA2 and IA3 components, 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 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.

21. Grievance Cell

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

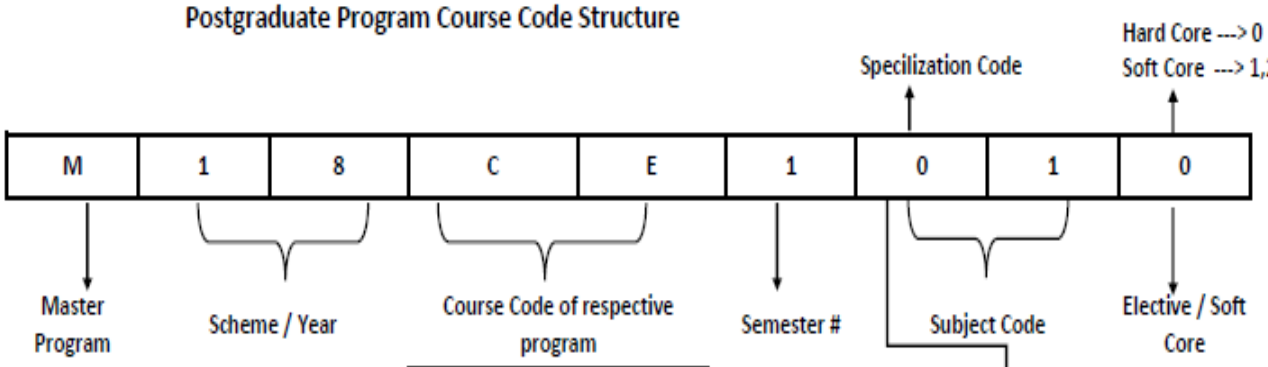
The Registrar (Evaluation) - Ex-Officio Chairman / Convener

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.

22.0. About any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

Postgraduate Program Course Code Structure



M.Tech (CSE)	CP
M.Tech (DEC)	DE
M.Tech (VLSI)	VL
M.Tech (MD)	MD
M.Tech (DCN)	DC
M.Tech (APE)	AP
M.Tech (CASE)	SE
M.Tech (TEM)	TE
M.Tech PT (CSE)	CP
M.Tech PT (VLSI)	VL
MBA	MB
M.Com	MC
MCA	MA
MS (CS)	MS
M.Sc (PH)	PH
M.Sc (CH)	CH
M.Sc (MT)	MT
M.Sc (BC)	BC
M.Sc (BT)	BT
MPA	PA
LLM	LM
MA (EN)	EN
MA (JR)	JM

M.Sc (Chemistry)-Sem III - Specialization course Code Example

Specilization Code		Course Code
Inorganic Chemistry	1	M18CH3110
Organic chemistry	2	M18CH3210
Physical Chemistry	3	M18CH3310

M Sc., in Mathematics

Eligibility: Passed Bachelor's Degree of 3 years with Mathematics as major / optional subject with 45% marks (40% in case of candidate belonging to SC/ST category) of marks in aggregate of any recognized / institution or any other qualification recognized as equivalent there to.

Scheme of Instruction

Semester I							
Course Code	Course Title	Course Type	Credits				Contact Hours
			L	T	P	Total	
MS17MT101	Algebra	HC	3	1	0	4	5
MS17MT102	Real Analysis	HC	3	1	0	4	5
MS17MT103	Statistical Methods - I	HC	3	1	0	4	5
MS17MT104	Discrete Mathematics	HC	3	1	0	4	5
MS17MT115	Ordinary and Partial Differential Equations	SC	3	1	0	4	5
MS17MT125	Number Theory	SC	3	1	0		
MS17MT106	R – Programming with Statistical Methods (Practical)	HC	0	0	2	2	3
	Total Credits of I Semester		**18**	**06**	**02**	**22**	**28**
Semester II							
MS17MT201	Linear Algebra	HC	3	1	0	4	5
MS17MT202	Complex Analysis	HC	3	1	0	4	5
MS17MT203	Graph Theory	HC	3	1	0	4	5
MS17MT204	Statistical Methods - II	HC	3	1	0	4	5
MS17MT215	Finite Element Method	SC	3	1	0	4	5
MS17MT225	Fluid Mechanics	SC	3	1	0		
MS17MT216	Python Programming and SPSS	SC	2	0	2	4	5
MS17MT226	SAS	SC	2	0	2		
	Total Credits of II Semester		**22**	**06**	**04**	**24**	**30**
Semester III							
MS17MT301	Topology	HC	3	1	0	4	5
MS17MT302	Magneto hydrodynamics	HC	3	1	0	4	5
MS17MT303	Functional Analysis	HC	3	1	0	4	5
MS17MT314	Computational Fluid Dynamics	SC	3	1	0	4	5
MS17MT324	Statistical Methods-III	SC	3	1	0		
MS17MT305	Mini Project work	HC	0	0	2	2	3
MS17MT3__	Open elective	OE	3	1	0	4	5
	Total Credits of III Semester		**18**	**06**	**02**	**22**	**28**
Semester IV							
MS17MT411	Calculus of Variation and Integral Equation	SC	3	1	0	4	5
MS17MT421	Measure Theory.	SC	3	1	0		
MS17MT402	Numerical Analysis	HC	3	1	0	4	5
MS17MT403	Operations Research	HC	3	1	0	4	5
MS17MT414	Mathematical Methods	SC	3	1	0	4	5
MS17MT424	Differential Geometry	SC	3	1	0		
MS17MT405	Project Work	HC	0	0	8	8	
MS17MT416	Fuzzy set & Fuzzy Logic	SC	3	1	0	4	5
MS17MT426	Advanced Graph Theory						
	Total Credits of IV Semester		**21**	**07**	**08**	**28**	**25**
	Total Credits of I to IV Semester					**96**	**111**

Total credits: 96 (HC = 64; SC = 28; OE=04)

Open Electives: 1. Optimization Techniques - (**MS17MT307**) 2. Cryptography - (**MS17MT308**)

DETAILED SYLLABUS- I SEMESTER

Sub Code: **MS17MT101**	**ALGEBRA**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Students will gain an understanding of the Cayley's theorem, Sylow's theorem and finite abelian group.
2. Students will study the ring and field over polynomials
3. Student will read and analyse Galois theory
4. Student will read and analyse the linear transformation, unitary and normal transformation.

Course Out comes:

Students can

1. Analyze the concept of various groups and theorems.
2. Analyze the concept of polynomial rings, polynomial rings over rational field, commutative ring and construct with straightedge and compass.
3. Analyze Galois Theory, Galois group over the rational and finite fields.
4. Apply the concept of linear transformation, canonical forms and real quadratics forms.

Unit I: **13 hrs**

Automorphisms, Cayley's theorem, Cauchy's theorem, permutation groups, symmetric groups, alternating groups, simple groups, conjugate elements and class equations of finite groups, Sylow's theorems, direct products, finite abelian groups, solvable groups

UNIT-II: **13 hrs**

Polynomial rings, polynomials rings over the rational field, polynomial rings over commutative rings, extension fields, roots of polynomials, construction with straightedge and compass, more about roots

UNIT-III: **13 hrs**

Galois Theory: The elements of Galois theory, solvability by radicals, Galois group over the rationals, finite fields

UNIT-IV: **13 hrs**

Algebra of linear transformations, characteristic roots, canonical forms - triangular, nilpotent and Jordan forms, Hermitian, unitary and normal transformations, real quadratic forms.

Reference Books:

1. M. Artin, Algebra, Prentice Hall of India, 1994.
2. I.N. Herstein, Abstract Algebra
3. D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, John Wiley, 2002.
4. J.A. Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa, 1999.
5. N. Jacobson, Basic Algebra I, 2nd Edition, Hindustan Publishing Co., 1984, W.H. Freeman, 1985.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT101	CO1	3	2	2		3		1	3	3	3
	CO2	3	3	2		2		1	2	3	3
	CO3	3	3	2		3		1	1	3	3
	CO4	3	3	2		2		1	2	3	3

Sub Code:**MS17MT102**	**REAL ANALYSIS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Students will gain an understanding of the Metric space, compact set and connected set.
2. Students will study the limit and continuous function
3. Student will read and analyse the Reimann - Stieltjes integrals
4. Student will read and analyse the sequence and series of functions

Course out comes: After this course the students shall be able to

1. Analyse the concept of Metric space, compact set and connected set
2. Analyse the concepts of continuity, compactness of continuity and monotone function
3. Apply the Riemann-Stieltjes integrals for various differentiation and integration problems
4. Apply the concept of Uniform convergence and continuity in differentiation, integration and polynomial

UNIT-I: Metric space **13 hrs**

Introduction, metric spaces-compact sets, Bolzano Weierstrass theorem, Heine - Borel theorem, perfect sets, connected sets.

Unit –II: Limit and Continuity **13 hrs**

Limits of functions- Continuous functions- Continuity and compactness Continuity and connectedness- Discontinuities – Monotone function and functions of bounded variation.

UNIT-III: Riemann-Stieltjes integral **13 hrs**

Riemann-Stieltjes integral; definition and existence of the integral, linear properties, change of variables, integral as a limit of sum. Integration and differentiation, integration of vector valued functions, Rectifiable curves.

UNIT-IV: Sequences and series of functions **13 hrs**

Sequences and series of functions: Uniform convergence- Uniform convergence and continuity- Uniform convergence and integration- Uniform convergence and differentiation- Approximation of a continuous function by a sequence of polynomials.

Reference Books

1. Walter Rudin, Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company, New York, 1976.
2. Bartle, R.G/Donald R.Sherbert. Introduction to Real Analysis, John Wiley and Sons Inc., 4th edition 2017.
3. Malik,S.C. and Savita Arora. Mathematical Anslysis, Wiley Eastern Limited.New Delhi, 1991.
4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.
5. A.L.Gupta and N.R.Gupta, Principles of Real Analysis, Pearson Education, (Indian print) 2003.
6. Tom M. Apostol :Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1997.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT102	CO1	3	3	1		2	2	1	1	3	3
	CO2	3	2	1		2	1	2	1	3	3
	CO3	3	2	1		2	2	2	1	3	3
	CO4	3	2	1		2	2	2	1	3	3

Sub Code: **MS17MT103**	**STATISTICAL METHODS - I**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1. Analyse the data numerically and graphically.
2. Apply the measures of location and measure of dispersion for grouped and ungrouped datas
3. Analyse the classical optimization techniques and numerical methods of optimization.
4. Apply the concepts of probability models to the real-world problems

Course Outcomes: At the end of the course, the student

1. Distinguish between qualitative and quantitative data and various scales of measurements.
2. Produce graphical representations of data
3. Compute the different measures of central tendency and dispersion and its various measures
4. Form the optimization problem and apply various optimization technique to solve real world problems.

5. Apply various methods of non-linear programming to compute engineering problems.

UNIT I: **13 hrs**

Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives, consistency and independence of data with special reference to attributes.

UNIT II: **13 hrs**

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections.

Unit III: **13 hrs**

Introduction: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems. Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.

Unit IV: **13 hrs**

Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods. Constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems.

Reference Books:

1.Dudewicz E.J and Mishra S.N (1988): Modern Mathematical Statistics, Wiley, International Students Edition.
2.Rohatgi V.K. (1984): An Introduction to probability theory and mathematical statistics.
3.Rao C.R (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.
4.Pitman J. (1993): Probability, Narosa Publishing House.
5.S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics. Sulthan and Chand Company.
6.Mukhopadhyay, P(2002), Mathematical Statistics, Books and Allied (p) Ltd., Kolkata.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT103	CO1	3	3	1	2	2	3	2	3	3	3
	CO2	3	2	1	1	1	2	2	3	3	3
	CO3	3	2	1		2	2	1	3	3	3
	CO4	3	2	1	1	2	2	1	3	3	3

Sub Code: **MS17MT104**	**DISCRETE MATHEMATICS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Recall basic Techniques in Counting
2. Demonstrate basic logic
3. Interpret the combinatorial ideas in practical problems
4. Develop the basics in Coding theory.

Course Out comes:

1. Distinguish the Tautologies and Controdictions
2. Analize the ideas of permutations and combinations.
3. Develop the ideas of Groups and Rings in Coding Theory
4. Apply the ideas of Posets and Lattices in Boolean Algebra

Unit-I: 13 hrs

Sets: Definition of sets, subsets, standard set operations; union, intersection, relative complement, symmetric difference, complement, Cartesian products, power sets; algebraic laws; cardinality of finite sets. Propositional logic, first order logic, Basic logical operation, Tautologies, contradictions, Logical equivalences, Predicates, Universal and existential quantifiers

Unit-II: 13hrs

Permutations and Combinations, Multinomial theorem, Circular Permutations, Solutions in Non-negative Integers, Set Partitions, Catalan Numbers, Advanced Counting Principles, Pigeonhole Principle , Principle of Inclusion and Exclusion

Unit-III: 13 hrs

Definitions, Examples, and Elementary Properties: Groups, Homomorphisms, Isomorphisms, and Cyclic Groups,Rings Coding Theory: Elements of Coding Theory, The Hamming Metric, The Parity Check, and Generator Matrices

Unit-IV: 13 hrs

Attices And Boolean Algebra: Partial ordering – Posets – Lattices as posets – Properties of lattices - Lattices as algebraic systems – Sub lattices – Some special lattices – Fundamentals of Boolean algebra.

Reference books:

1. Discrete Mathematics and Its Applications, By Kenneth H Rosen, McGraw Hill, Sept.2002.
2. "Graph Theory with Applications to Engineering and Computer Science" Prentice Hall, Englewood Cliffs, 1974
3. Combinatorics: Theory and Applications, By V. Krishnamurthy, East-West Press Pt. Ltd., New Delhi, 1986.
4.Discrete Mathematical Structures with Applications to Computer Science, By J. Tremble, Manohar, McGraw Hill Pub, 1975.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT104	**CO1**	3	2	2	1	1		1	2	3	3
	CO2	3	2	2	1	1		1	2	3	3
	CO3	3	2	2	1	1		1	2	3	3
	CO4	3	2	2	1			1	3	3	3

Sub Code: **MS17MT115**	**ORDINARY AND PARTIAL**	C	L	T	P	CH
Duration: 14 Weeks	**DIFFERENTIAL EQUATIONS**	4	3	1	0	5

Course Objectives:

1. Identify essential characteristics of ordinary differential equations.
2. To develop strong background on finding solutions to linear second order differential equations with constant and variable coefficients.
3. Partial differential equations allow deterministic mathematical formulations of phenomena in physics and engineering as well as biological processes
4. This course is to present the main results in the context of partial differential equations that allow learning about these models and to study numerical methods for the approximation of their solution.

Course Out comes:

1. Compute the Wronskian using variation of parameter method
2. Solve different types of differential equations using power series method
3. Solve first order and second order partial differential equations by reducing in to canonical form
4. Solve the PDE by variable separable method.

Unit-1: **13 hrs**

Linear differential equations of nth order, fundamental sets of solutions, Wronskian - Abel's identity, theorems on linear dependence of solutions. The n^{th} order non-homogeneous linear equations - Variation of parameter method, zeros of solutions - comparison and separation theorems. Eigen value problems - Sturm-Liouville problems - Orthogonality of eigen functions, Green's function method. Fundamental existence and uniqueness theorem-Picards method.

Unit-2: **13 hrs**

Power series solution of linear differential equations - ordinary and singular points of differential equations, Classification into regular and irregular singular points; Series solution about an ordinary point and a regular singular point - Frobenius method- Hermite, Laguerre, Chebyshev and Gauss Hypergeometric equations and their general solutions. Generating function, Recurrence relations, Rodrigue's formula Orthogonality properties.

Unit 3: **13 hrs**

First Order Partial Differential Equations- Cauchy problem, the method of characteristics for Semi linear, quasi linear and Non-linear equations. Classification of second-order linear partial differential equations into hyperbolic, parabolic and elliptic PDEs, Reduction to canonical forms.

Unit 4: **13 hrs**

Homogeneous and non-homogeneous PDE with constant coefficients, second order PDE with variable coefficients, Heat equation, Wave equation: Solution by the method of separation of variables. Laplace equation: Solution by the method of separation of variables.

REFERENCE BOOKS

1. G.F. Simmons: Differential Equations, TMH Edition, New Delhi, 1974.
2. M.S.P. Eastham: Theory of ordinary differential equations, Van Nostrand, London, 1970.
3. S.L. Ross: Differential equations (3rd edition), John Wiley & Sons, New York, 1984.
4. I. N. Sneddon, Elements of PDE's, McGraw Hill Book company Inc., 2006.
5. L Debnath, Nonlinear PDE's for Scientists and Engineers, Birkhauser, Boston, 2007.
6. F. John, Partial differential equations, Springer, 1971.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT115	CO1	3	3	1		2	1	2	2	3	3
	CO2	3	2	1		1		3	3	3	3
	CO3	3	2	1		1		3	3	3	3
	CO4	3	2	1		1		2	2	3	3

Sub Code: **MS17MT125**	**NUMBER THEORY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives: This course is concerned with the basics of analytical number theory.

1. Topics such as divisibility, congruence's, quadratic residues and functions of number theory are covered in this course.
2. Some of the applications of the said concepts are also included.

Course Outcome: The students can

1. Define and interpret the concepts of divisibility, congruence, greatest common divisor, prime, and prime-factorization,
2. Solve linear Diophantine equations and congruences of various types, and use the theory of congruences in applications.
3. Prove and apply properties of multiplicative functions such as the Euler phi-function and of quadratic residues.
4. Apply the Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues,

Unit I: **13 hrs**

Number theory - Congruences, residue classes, theorems of Fermat, Euler and Wilson, linear congruences, elementary arithmetical functions, primitive roots, quadratic residues and the law of quadratic reciprocity.

Unit II: **13 hrs**

Prime numbers, The Fundamental theorem of Arithmetic, The series of Reciprocals of primes, The Euclidean Algorithm. Fermat and Mersenne numbers. Farey series, Farey dissection of the continuum, Irrational Numbers-Irrationality of mth root of N, e and π, Diophantine equations.

Unit III: **13 hrs**

Arithmetical Functions – The Mobius function, The Euler' function and Sigma function, The Dirichlet product of Arithmetical functions, Multiplicative functions. Averages of Arithmetical functions – Euler summation formula, Some elementary asymptotic formulas, The average orders of d(n), $\sigma(n)$, $\varphi(n)$, $\mu(n)$. Approximation Irrational numbers, Hurwitz's Theorem, Representation of a number by two or four squares.

Unit IV: **13 hrs**

Continued fractions - Finite continued fractions, Convergent of a continued fraction, Continued fractions with positive quotients. Simple continued fractions, The representation of an irreducible rational fraction by a simple continued fraction. The continued fraction algorithm and Euclid's algorithm. The difference between the fraction and its convergents, Infinite simple continued fractions, the representation of an irrational number by an infinite continued fraction, Equivalent numbers and periodic continued fractions.

Reference Books:

1. D. M. Burton, Elementary number theory, McGraw Hill.
2. Hardy, G.H. and Wright, E.M., An Introduction to the Theory of Numbers (6th ed, Oxford University Press, (2008).
3. Niven, H. S. Zuckerman and H. L. Montgomery, An Introduction To The Theory Of Numbers, 5 th Edition, Wiley Student Editions
4. Apostol, T.M., Introduction to Analytic number theory, UTM, Springer, (1976).

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT125	CO1	3	3	1		2	1	2	2	3	3
	CO2	3	2	1		1		3	3	3	3
	CO3	3	2	1		1		3	3	3	3
	CO4	3	2	1		1		2	2	3	3

Sub Code: **MS17MT106**	**R-PROGRAMMING**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Outcome: The students can

1. Develop a R-script with available data types and operators.
2. Apply decision and repetition structures in R-script.
3. Develop simple programs in R for mathematical problems.
4...Illustrate graphical visualizations of data and demonstrate the probability distributions using R

Introduction to R-Programming

Prerequisite: Students should have a basic understanding of Computer Programming terminologies. A basic understanding of any of the programming languages will help you in understanding the R programming concepts and move fast on the learning track.

Fundamentals in R: basic syntax : R command prompt , script file ,comments, data types : lists ,matrices , arrays, factors ,data frames , variables: variable assignment ,data type of a variable, finding variables ,deleting variables, operators: types of operators ,arithmetic operators , relational operators, logical operators , assignment operators, miscellaneous operators , decision making : if statement ,if...else statement ,the if...else if...else statement ,switch statement, Loops, Functions, R-graphical representation of Data, R-measure of central tendency, R-regression ,R-distributions (Binomial and Normal).

R List of Experiments:

1. Write an R script to demonstrate use of variables.

2. Write an R script to demonstrate use of vector and matrix data types.

3. Write an R script to demonstrate use of Data frames.

4. Write an R script to demonstrate use of Lists.

5. Write an R script to demonstrate use of conditional statements if, if-else.

6. Write an R script to demonstrate use of arithmetic, logical operators.

7. Write an R script to demonstrate use of loops.

8. Write an R script to demonstrate use of functions.

9. Write an R script to demonstrate use of visualizations in R - basic plot, ggplot

10.Write an R script to demonstrate use of 3d visualization in R-scatterplot3d

11. Write an R script to demonstrate use of probability library - prob to find probability of coin toss.

12. Write an R script to demonstrate use of set operations .

13. Write an R script to demonstrate use of conditional probability.

14. Write an R script to demonstrate use of covariance on a data set.

15. Write an R script to demonstrate use of correlation on a data set.

16. Write an R script to demonstrate use of linear regression.

17. Write an R script to demonstrate use of multiple regression

18. Write an R script to demonstrate use of logistic regression

19. Write an R script to demonstrate use of normal distribution

20. Write an R script to demonstrate use of binomial distribution

Books for References:

1. The R Book by Michael R Crawley, John Wiley & Sons Ltd.

2. The Art of R-Programming by Norman Matloff.

3. R cook book by Paul teetor, Oreilly Ltd.

4. Introduction to Probability and Statistics Using R,G. Jay Kerns, First Edition.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT106	CO1	3	2	1	1			1		3	3
	CO2	3	2	1	1			1		3	3
	CO3	3	2	1	1		1		1	3	3
	CO4	3	2	2		1		1	2	3	3

II SEMESTER

Sub Code: **MS17MT201**	**LINEAR ALGEBRA**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives: This course will:

1. Recall basic concepts of matrices and matrix algebra
2. Present methods of solving systems of linear equations
3. Demonstrate basic concepts of vector spaces
4. Interpret the concepts of linear transformations by using the matrices
5. Develop methods of computing and using eigen values and eigenvectors..

Course Outcomes: Students in this course will:

1. Solve the system of Linear Equations by using Matrix Algebra
2. Derive the Norms and Inner Product Spaces
3. Summarize the vector space properties.
4. Analyze different forms of the Linear Transformations

Unit I: **13 hrs**

Vector Spaces, Subspaces, Linear Combinations and Systems of Linear Equations, Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets; Linear Transformations, Null Spaces, and Ranges, The Matrix Representation of a Linear Transformation, Composition of Linear Transformations, and Matrix Multiplication, Invertibility and Isomorphisms, The

Change of Coordinate Matrix, The Dual Space; Elementary Matrix Operations and Elementary Matrices, The Rank of a Matrix and Matrix Inverses, Systems of Linear Equations.

Unit II: **13 hrs**

Properties of Determinants, Cofactor Expansions, Elementary Operations and Cramer's Rule; Eigenvalues and Eigenvectors, Diagonalizability, Invariant Subspaces and the Cayley-Hamilton Theorem; Inner Products and Norms, The Gram-Schmidt Orthogonalizing Process and Orthogonal Complements.

Unit III: **13 hrs**

The Adjoint of a Linear Operator, Normal and Self-Adjoint Operators, Unitary and Orthogonal Operators and Their Matrices, Orthogonal Projections and the Spectral Theorem; Bilinear and Quadratic Forms.

Unit IV: **13 hrs**

The Diagonal form, The Triangular form; The Jordan Canonical Form; The Minimal Polynomial; The Rational Canonical Form.

Books for Reference:

1. S. Friedberg, A. Insel, and L. Spence - Linear Algebra, Fourth Edition, PHI, 2009.
2. Jimmie Gilbert and Linda Gilbert – Linear Algebra and Matrix Theory, Academic Press, An imprint of Elsevier.
3. I. N. Herstein – Topics in Algebra, Vikas Publishing House, New Delhi.
4. Hoffman and Kunze – Linear Algebra, Prentice-Hall of India, 1978, 2nd Ed.,
5. P. R. Halmos – Finite Dimensional Vector Space, D. Van Nostrand, 1958.
6. S. Kumeresan – Linear Algebra, A Geometric approach, Prentice Hall India, 2000.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT201	CO1	3	2	1	2	1			2	3	3
	CO2	3	2	1	2	1		1	1	3	3
	CO3	3	2	1	1			1	2	3	3
	CO4	3	2	1	2	1		1	3	3	3

Sub Code: **MS17MT202**	**COMPLEX ANALYSIS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Objectives :

1. Students will study the analytic function and Cauchy;s theorem for triangular, rectangular, circular regions also Liouliies theorem.
2. Students will study Power series
3. Student will read and analyse the singularities.
4. Student will read and analyse the Residues theorem, and Contour integrals.

Course Outcomes:

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

1. Analyze the limit and continuity for function of complex variable
2. Evaluate Complex Contour integrals by applying the Cauchy's integral theorem in its various versions.
3. Analyze sequences and series of analytic functions and types of convergence.
4. Evaluate complex integrals using residues theorem.

Unit I: **13 hrs**

Analytic functions, Harmonic conjugates, Elementary functions, Mobius Transformation, Conformal mappings, Cauchy's Theorem and Integral formula, Morera's Theorem, Cauchy's Theorem for triangle, rectangle, Cauchy's Theorem in a disk, Zeros of Analytic function. The index of a closed curve, counting of zeros. Principles of analytic Continuation. Liouville's Theorem, Fundaments theorem of algebra**.**

Unit II: **13 hrs**

Series, Uniform convergence, Power series, Radius of convergences, Power series representation of Analytic function, Relation between Power series and Analytic function, Taylor's series, Laurent's series. Rational Functions

Unit III: **13 hrs**

Singularities, Poles, Classification of Singularities, Characterization of removable Singularities, poles. Behavior of an Analytic functions at an essential singular point. Entire and Meromorphic functions.

Unit IV: **13 hrs**

The Residue Theorem, Evaluation of Definite integrals, Argument principle, Rouche's Theorem, Schwartz lemma, Open mapping and Maximum modulus theorem and applications, Convex functions, Hadmard's Three circle theorem**.**

Reference Books

1. S. Ponnaswamy : Functions of Complex variable, Narosa Publications-1997
2. J. B. Conway : Functions of one complex variable, Narosa, 1987.
3. L.V. Ahlfors : Complex Analysis, McGraw Hill, 1986.
4. R. Nevanlinna :Analystic functions, Springer, 1970.
5. E. Hille : Analytic Teory, Vol. I, Ginn, 1959.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT202	**CO1**	3	2	1		1		1	1	3	3
	CO2	3	2	2	1			1	2	3	3
	CO3	3	1	2	1	1		1	1	3	3
	CO4	3	2	1	1			1	1	3	3

Sub Code: **MS17MT203**	**GRAPH THEORY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. This course is aimed to Demonstrate variety of problems in Graph Theory.

2. In this course students will Interpret Theorems in real life scenario
3. This course is aimed to interpret various techniques to find shortest distance in a network
4. This course will demonstrate the graphs algorithms.

Course Outcomes: After the course the student

1. Apply the concept of connectivity to solve utility problems, mapping problems.
2. Apply the concept of planarity to solve 2D circuit problem (minimizing the number of intersection of wires).
3. Apply the concept of colorability to solve Sudoku problem, mobile frequency assignment problem.
4. Apply the concept of matching to estimate the bond lengths and to solve TSP and Apply the concept of domination to solve routing problem, locating

.

Unit – 1: **Introduction to graph theory** 13 Hrs

Definition and introductory concept, Graphs as Models, Isomorphism, Decomposition and special graphs, Connected graphs, Bipartite Graphs, Eulerian Graphs, Hamilton Graphs, Directed Graphs, Vertex Degrees, Graphic Sequences, Orientation and Tournaments.

Unit – 2: **Trees and Planar Graphs** 13 Hrs

Properties of Trees, Distance in Trees and Graphs, Enumeration of Trees, Spanning Trees in Graphs, Decomposition and Graceful Labelins, Minimum Spanning Tree, Shortest Paths, Minimal Spanning tree algorithm, Planar graphs, Dual of the Planar Graphs, Euler's Formula, Kuratowskis's Theorem. Thickness and crossing Number.

Unit – 3: **Connectivity and Paths** 13 Hrs

Connectivity, Edge Connectivity, Block, 2-Connected Graphs, Connectivity in Digraphs, K – Connected and k – edge connected Graphs, Menger's Theorem, Maximum Network Flow, Integral Flows.

Unit – 4 : **Coloring of Graphs** 13 Hrs

Definition and Examples of Graph coloring, Chromatic number, Chromatic Polynomial of a Graphs, Four Color Problem, Five Color Theorem, Brookes Theorem, Graph with Large Chromatic Number, Turan's Theorem, Color Critical Graphs.

REFERENCE BOOKS

1. F. Harary: Graph Theory, Addison -Wesley,1969
2. G.Chartrand and Ping Zhang: Introduction to Graph Theory. McGrawHill, International edition (2005)
3. J.A.Bondy and V.S.R.Murthy: Graph Theory with Applications, Macmillan, London, (2004).
4. D.B.West, Introduction to Graph Theory,Pearson Education Asia, 2nd Edition, 2002.
5. Charatrand and L. Lesnaik-Foster: Graph and Digraphs, CRC Press (Third Edition), 2010.
6. T.W. Haynes, S.T. Hedetneime and P. J. Slater: Fundamental of domination in graphs, Marcel Dekker. Inc. New York.1998.
7. J. Gross and J. Yellen: Graph Theory and its application, CRC Press LLC, Boca Raton, Florida, 2000.
8. N. Deo: Graph Theory: Prentice Hall of India Pvt. Ltd. New Delhi – 1990

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2

MS17MT203	**CO1**	3	2	2	1	1		1	2	3	3
	CO2	3	2	2	1	1		1	2	3	3
	CO3	3	2	2	1	1		1	2	3	3
	CO4	3	2	2	1			1	3	3	3

Sub Code: **MS17MT204**	**STATISTICAL METHODS- II**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1.Explore random variable, various distributions, and statistical independence.

2. Understand the probability mass and density functions of various random variables and their distributions.

3.Explore applications of continuous and discrete distributions.

4. Carry out statistical hypothesis tests for population mean and proportions.

5.Understand correlation and regression models and their coefficients.

Course Outcomes:

By completing this course the student shall be able to:

1. Analyze the concepts of random variable techniques to generate data from various distributions.

2. Analyze the concepts of functions of random variables and their distribution using Jacobian transformation

3. Apply selected probability distributions for different kinds of problems

4. Analyse the data using appropriate statistical distributions (t, f *and* χ^2)

UNIT – I: 13 hrs

Probability as a set function, continuity axiom of probability, Borel - Cantelli lemma, random variable, distribution function and its properties, discrete and continuous distribution functions, convolutions of random variables, vector of random variables and statistical independence. Notion of mathematical expectation, conditional expectation, moment inequalities – Markov, Chebyshev, Kolmogorov, Holder, minkowski. Characteristic function – Inversion theorem.

UNIT – II: 13 hrs

Brief review of basic distribution theory, joint, marginal and conditional p.m. functions and p.d. functions. Rectangular, normal, exponential, gamma, beta, Cauchy, Laplace, and Weibull distributions. Functions of random variables and their distributions using Jacobian of transformations.

UNIT – III: **13 hrs**

Discrete distributions & Continuous distributions: Definitions, moment generating functions, probability generating functions, characteristic functions, means, variances, reproductive properties (if exist) and interrelations of multinomial, compound binomial, Compound Poisson (for Discrete) and interrelations of Weibull, Laplace, lognormal, logistic (for Continuous).
Distributions: Central Chi Square, t and F distributions and its properties, applications, relation between t and F, F and $\chi 2$; Fisher's Z-distribution, fisher's Z - transformation.

UNIT-IV: **13 hrs**

Statistical Hypothesis: Null and Alternative, simple and composite, Type I and Type II errors. Test function. Power of the test and level of significance. Parameters and estimates.
Analysis of Variance: Meaning and assumptions, fixed, random and mixed models. Principles – One way and two way classification models with and without interaction effect.
Correlations and Regression modelling, Multiple and partial correlation coefficients, multiple linear regression, inter relationship among partial and multiple correlation and regression coefficients. Null distributions of simple, partial, and multiple correlation coefficients.

References Books:
1.Anderson, T.W (1983), An introduction to Multivariate Statistical Analysis, Wiley, 2nd Edition.
2.Rao, C.R (1973), Linear Statistical Inference and its applications, 2nd edition, Wiley
3.Srivastava. M.S and Khatri, C.G (1979), An introduction to Multivariate Statistics, North Holland
4.Morrison,F(1985): Multivariate Statistical Methods, Mc Graw Hill Book Company.
5.Johnson A.R and Wishern, D.W (1996), Applied Multivariate Statistical Analysis, Prentice Hall of India
6.Sharma, S (1996), Applied Multivariate Techniques, Wiley.
7.Krishisagar, A.M (1972), Multivariate Analysis, Marcel Dekker
8.K.C. Bhuyan(2005): Multivariate Analysis and its Applications, Central

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT204	CO1	3	2	2		1	1	1	2	3	3
	CO2	3	2	1		1		1	2	3	3
	CO3	3	1	2	1	1		1	2	3	3
	CO4	3	2	2	1				2	3	3

Sub Code: **MS17MT215**	**FINITE ELEMENT METHOD**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:
1. Illustrate about different finite element methods in one, two and three dimensions.
2. Analyse variety of finite elements as per the requirements of solutions of differential equations.
Course Outcomes: Upon completion of this course, the student will be able to:

1.Apply finite element method to solve Differential equations.
2. Apply finite element method to solve heat transfer problems.
3. Apply finite element method to solve two and three dimensional problems.
4. Apply finite element method to solve Laplace &Poisson equations of specific applications

Unit I: **13hrs**

Weighted Residual Approximations: Point collocation, Galerkin and Least Squares method. Use of trial functions to the solution of differential equations.

Unit II: **13hrs**

Finite Elements: One dimensional and two-dimensional basis functions, Lagrange and serendipity family elements for quadrilaterals and triangular shapes. Isoparametric coordinate transformation. Area coordinates standard 2- squares and unit triangles in natural coordinates.

Unit III: **13hrs**

Finite Element Procedures: Finite Element Formulations for the solutions of ordinary and partial differential equations: Calculation of element matrices, assembly, and solution of linear equations.

Unit IV: **13hrs**

Finite Element solution of one dimensional ordinary differential equations, Laplace and Poisson equations over rectangular and nonrectangular and curved domains. Applications to some problems in linear elasticity: Torsion of shafts of a square, elliptic and triangular cross sections.

REFERENCE BOOKS:

1. O.C. Zienkiewiez and K. Morgan : Finite Elements and approximation, John Wieley, 1983
2. P.E. Lewis and J.P. Ward : The Finite element method- Principles and applications, Addison Weley, 1991
3. L.J. Segerlind : Applied finite element analysis (2nd Edition), John Wiley, 1984
4. OC Zienkiewicz, RL Taylor: The FEM. Vol.1 Basic formulation and Linear problems, 4Ed, NY, MGH, 1989.
5. J.N. Reddy: An introduction to finite element method, New York, Mc.Graw Hill, 1984.
6. D.W. Pepper, J.C. Heinrich : The finite element method, Basic concepts and applications, Hemisphere, Publishing Corporation, Washington, 1992.
7. S.S. Rao : The finite element method in Engineering, 2nd Edition, Oxford, Pergamon Press, 1989.
8. D. V. Hutton, fundamental of Finite Element Analysis, (2004).
9. EG Thomson, Introduction to FEM, Theory Programming and applications, Wiley Student Ed, (2005).

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT215	CO1	3	3	1		1		1	2	3	3
	CO2	3	2	1		1		2	2	3	3
	CO3	3	2	1		1		2	1	3	3
	CO4	3	2	1		2		2	3	3	3

Sub Code: **MS17MT225**	**FLUID MECHANICS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

This course aims at studying the fundamentals of fluid mechanics such as tensors, kinematics of fluid, incompressible flow, and boundary layer flows.

1. This course aims at study of fluid flows such as viscous flow, inviscid flow, incompressible flow, and boundary layer flows.

Course outcomes:

1. Apply the concepts of tensors in continuum hypothesis, material and spatial coordinates
2. Analyze the laws of conservations
3. Analyze the dimensional and non-dimensional parameters
4. Analyze the different types of fluid flow problems.

Unit I: **13hrs**

Coordinate transformations - Cartesian tensors - Basic Properties - Transpose - Symmetric and Skew tensors - Isotropic tensors- Deviatoric Tensors - Gradient, Divergence and Curl in Tensor Calculus - Integral Theorems. Continuum Hypothesis- Configuration of a continuum – Mass and density – Description of motion – Material and spatial coordinates - Translation – Rotation - Deformation of a surface element- Deformation of a volume element - Isochoric deformation – Examples - Stretch and Rotation- Decomposition of a deformation- Deformation gradient - Strain tensors - Infinitesimal strain - Compatibility relations - Principal strains.

Unit II: **13hrs**

Material and Local time derivatives. - Strain-rate tensor- Transport formulas – Stream lines - Path lines - Vorticity and Circulation - Examples. Stress components and Stress tensor - Normal and shear stresses - Principal stresses. Fundamental basic physical laws- Law of conservation of mass - Principle of linear and momentum - Balance of energy - Examples. Equations of fluid mechanics – Viscous and non-viscous fluids –Stress tensor for a viscous fluid – Navier-Stokes equation - simple consequences and simple applications.

Unit III: **13hrs**

Motion of inviscid fluids:- Recapitulation of equation of motion and standard results - Vortex motion- Helmholtz vorticity equation - Permanence of vorticity and circulation - Kelvin's minimum energy theorem – Impulsive motion - Dimensional analysis - Nondimensional numbers. Two dimensional flows of inviscid fluids:- Meaning of two-dimensional flow - Stream function – Complex potential - Line sources and sinks - Line doublets and vortices - Images - Milne-Thomson circle theorem and applications - Blasius theorem and applications.

Unit IV: **13hrs**

Motion of Viscous fluids:- Stress tensor – Navier-Stokes equation - Energy equation - Simple exact solutions of Navier-Stokes equation: (i) Plane Poiseuille and Hagen- Poiseuille flows (ii) Generalized plane Couette flow (iii) Steady flow between two rotating concentric circular cylinders (iv) Stokes's first and second problems. Diffusion of vorticity - Energy dissipation due to viscosity.

Reference Books:

1. D.S. Chandrasekharaiah and L. Debnath: Continuum Mechanics, Academic Press, 1994.
2. A.J.M. Spencer: Continuum Mechanics, Longman, 1980.
3. S. W. Yuan : Foundations of Fluid Mechanics, Prentice Hall, 1976.
4. P. Chadwick : Continuum Mechanics, Allen and Unwin, 1976.
5. L.E. Malvern : Introduction to the Mechanics of a Continuous Media, Prentice Hall,1969.
6. Y.C. Fung, A First course in Continuum Mechanics, Prentice Hall (2nd edition), 1977.
7. Pijush K. Kundu, Ira M. Cohen and David R. Dowling, Fluid Mechanics, Fifth Edition , 2010.
8. C.S.Yih : Fluid Mechanics, McGraw-Hill, 1969.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT225	CO1	3	2	1		1		1		3	3
	CO2	3	2	2		2		1		3	3
	CO3	3	2	2		1		1		3	3
	CO4	3	2	2		1		1		3	3

Sub Code: **MS17MT216**	**PYTHON PROGRAMMING and SPSS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1. To introduce students to the features of R.
2. To enable the students to write simple scripts using control structures and conditons.
3. To enable the students to create graphical representations
4. To enable students to perform regression analysis

Course Outcomes:

After learning the course, the student will be able:

1.Explain the basic constructs in Python
2. Apply control structures in Python
3. Develop programs with lists , tuples lists, strings, sets and dictionaries.
4.Apply elementary techniques in Python programming

UNIT-I : **13 hrs**

Introduction to Python The basic elements of python, Branching Programs, Control Structures, Strings and Input, Iteration , Functions, Scoping and Abstraction Functions and scoping, Specifications, Recursion, Global variables, Modules, Files, System Functions and Parameters

UNIT-II : **13 hrs**

Structured Types, Mutability and Higher-Order Functions Strings, Tuples, Lists and Dictionaries, Lists and Mutability, Functions as Objects, Testing, Debugging, Exceptions and Assertions Types of testing – Black-box and Glass-box, Debugging, Handling Exceptions

UNIT-III : **13 hrs**

Classes and Object-Oriented Programming Abstract Data Types and Classes, Inheritance, Encapsulation and Information Hiding

UNIT-IV : **13 hrs**

Simple Algorithms and Data structures Search Algorithms, Sorting Algorithms, Hash Tables

Reference Books:

1. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India
2. R. Nageswara Rao, "Core Python Programming", dreamtech
3. Wesley J. Chun. "Core Python Programming - Second Edition", Prentice Hall
4. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Pyhon", Wiley
5. Kenneth A. Lambert, "Fundamentals of Python – First Programs", CENGAGE Publication
6. Luke Sneeringer, "Professional Python", Wrox "Hacking Secret Ciphers with Python", Al Sweigart, URLhttps://inventwithpython.com/hacking/chapter

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT216	CO1	3	2	1		1			3	3	3
	CO2	3	2	1		1			3	3	3
	CO3	3	2	2		1			3	3	3
	CO4	3	2	1		1			3	3	3

III SEMESTER

Sub Code: **MS17MT301**	**TOPOLOGY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1. To explore the foundations of mathematics (logic and set theory) at a level and depth appropriate for someone aspiring to study higher-level mathematics and/or to become a professional mathematician.
2. To present an introduction to the field of topology, with emphasis on those aspects of the subject that are basic to higher mathematics.
3. To introduce the student to what it means to do mathematics, as opposed to learning about mathematics or to learning to do computational exercises.

Course Outcomes: After the completion of the course, students will

1. Explain the Basic of Topology
2. Identify different types of Topologies
3. Analyze the Connectedness and compactness
4. Prove different Axioms and Theorems by Urysohn's concepts and Tychonoff's results

UNIT-I: Topological Spaces **13 hrs**

Basic Concepts , The Metric Topology, Interior Points, Limit Points, Boundary Points, Closure of a Set , Hausdorff Topological Spaces, Continuous Functions .

UNIT-II: Product and Quotient Spaces **13hrs**

Product Space, Connected Spaces , Connected Subsets of the Real Line, Some Properties of Connected Spaces, Connected Components

UNIT-III: Connected Topological Spaces **13 hrs**

Compact Spaces and Related Results, Local Compactness , One Point Compactification of a Topological Space (X,J) , Tychonoff Theorem for Product Spaces

UNIT-IV: Countability and Separation Axioms **13 hrs**

First and Second Countable Topological Spaces , Properties of First Countable Topological Spaces , Regular and Normal Topological Spaces , Urysohn Lemma, Tietze Extension Theorem, Baire Category Theorem, Urysohn Metrization Theorem

Reference Books

1. J.R. Munkres,*Topology*, Second Edition, Prentice Hall of India, 2007.
2. Simmons,G.F. *Introduction to topology and modern analysis*, Tata McGraw Hill, 1963.
3. Dugundji,J. *Topology*, Prentice Hall of India, 1966.
4. Willard, *General topology*, Addison-Wesley, 1970.
5. Crump, W. Baker, *Introduction to topology*, Krieger Publishing Company, 1997.
6. Topology Without Tears by "SIDNEY A MORRIS',VERSION OF Feb 23, 2018

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT301	**CO1**	3	2	1	1	2		1		3	3

	CO2	3	2	2	1	2		1		3	3
	CO3	3	2	1		1		1		3	3
	CO4	3	1	2		1		1		3	3

Sub Code: **MS17MT302**	**MAGNETO HYDRODYNAMICS**	C	L	T	P		CH
Duration: 14 Weeks		4	3	1	0		5

Course Objectives:

1. This course helps the students to understand the basic concepts of heat transfer, types of convection shear and thermal instability of linear and non-linear problems, dimensional analysis.
2. The flow problems are analyses using finite element method.

Course Outcomes:

1. Understand both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution.
2. An introduction to the theory and practice of the finite element method. Experience with writing a simple finite element solver for an ordinary differential equation.
3. Understanding of physics of compressible and incompressible fluid flows.
4. Ability to solve the fluid flow equations using Finite element method.

Unit I: **13hrs**

Review of partial differential equations, numerical analysis, fluid mechanics. Finite Difference Methods: Derivation of finite difference methods, finite difference method to parabolic, hyperbolic and elliptic equations, finite difference method to nonlinear equations, coordinate transformation for arbitrary geometry.

Unit II: **13hrs**

Central schemes with combined space-time discretization-Lax-Friedrichs, Lax-Wendroff, MacCormack methods, Artificial compressibility method, pressure correction method – Lubrication model, Convection dominated flows – Euler equation – Quasilinearization of Euler equation, Compatibility relations, nonlinear Burger equation.

Unit III: **13hrs**

Finite Volume Methods: General introduction, Node-centered-control volume, Cell-centered-control volume and average volume, Cell-Centred scheme, Cell-Vertex scheme, Structured and Unstructured FVMs, Second and Fourth order approximations to the convection and diffusion equations (One and Two-dimensional examples).

Unit IV: **13hrs**

Finite Element Methods: Introduction to finite element methods, one-and two-dimensional bases functions – Lagrange and Hermite polynomials elements, triangular and rectangular elements, Finite element method for one-dimensional problem: model boundary value problems, discretization of the domain, derivation of elemental equations and their connectivity, composition of boundary conditions and solutions of the algebraic equations. Finite element method for two-dimensional problems: model equations, discretization, interpolation functions, evaluation of element matrices and vectors and their assemblage.

REFERENCE BOOKS

1. T. J. Chung: 'Computational Fluid Dynamics', Cambridge Univ. Press, 2003.
2. J Blazek, ' Computational Fluid Dynamics', Elsevier, 2001.

3. Harvard Lomax, Thomas H. Pulliam, David W Zingg, 'Fundamentals of Computational Fluid Dynamics', NASA Report, 2006.
4. C.A J. Fletcher: 'Computational techniques for Fluid Dynamics', Vol. I & II, Springer Verlag 1991.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT302	CO1	3	2	1	1	2		1		3	3
	CO2	3	2	2	1	2		1		3	3
	CO3	3	2	1		1		1		3	3
	CO4	3	1	2		1		1		3	3

Sub Code: **MS17MT303**	**FUNCTIONAL ANALYSIS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. To understand the concepts of linear transformation, isomorphism, normed linear space and Banach space.
2. To familiarize about open mapping theorem, closed graph theorem and uniform boundedness theorem.
3. To understand the concepts of Hilbert spaces, Schwarz inequality, conjugate space, finite dimensional spectral theory.

Course Outcomes:

1. Analyze the concepts of linear transformation, isomorphism, normed linear space and Banach space.
2. Analyze the concept of open mapping theorem, closed graph theorem and uniform boundedness theorem.
3. Analyze the concepts of Hilbert spaces, Schwarz inequality, parallelogram law, Bessel inequality.
4. Analyze the concept of conjugate space, finite dimensional spectral theory.

Unit-I: 13 hrs

Normed linear spaces, Banach spaces, continuous linear transformations, isometric isomorphisms, functionals and the Hahn-Banach theorem, the natural embedding of a normed linear space in its second dual

Unit-II: 13 hrs

The open mapping theorem and the closed graph theorem, the uniform boundedness theorem, the conjugate of an operator 12 hrs

Unit-III: 13 hrs

Inner products, Hilbert spaces, Schwarz inequality, parallelogram law, orthogonal complements, orthonormal sets, Bessel's inequality, complete orthonormal sets 12 hrs

Unit-IV: 13 hrs

The conjugate space, the adjoint of an operator, self-adjoint, normal and unitary operators, projections, finite dimensional spectral theory. 12 hrs

ReferenceBooks :

1. G.F. Simmons, Introduction to topology and modern Analysis, Reprint, Tata McGraw-Hill, 2004
2. K. Yoshida, Functional analysis, 6th ed., Springer, 1996.
3. E. Kreyszig, Introductory functional analysis with applications, 1st ed., John Wiley, 1978.
4. B.V. Limaye, Functional analysis, 2nd ed., New Age International, 1996.
5. W. Rudin, Functional analysis, 2nd ed., McGraw Hill, 2010.
6. S. Karen, Beginning functional analysis, Reprint, Springer, 2002.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT303	CO1	3	2	2	2			1	1	3	3
	CO2	3	1	1	2	2		1	2	3	3
	CO3	3	2	1	2	1		2	2	3	3
	CO4	3	2	1	2	1		1	2	3	3

Sub Code: **MS17MT314**	**COMPUTATIONAL FLUID DYNAMICS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1. Explains the basic concepts of heat transfer, types of convection, thermal instability of linear and non-linear problems, dimensional analysis.
2. Flow problems are analysed using finite element method.

Course Outcome:

1. Apply the concepts of Finite Difference method to solve various types of Partial Differential Equations.
2. Analyze the concepts of physics of compressible and incompressible fluid flows.
3. Apply finite volume method to solve the fluid flow equations.
4. Apply finite element method to solve one- dimensional and two-dimensional problems

Unit I: 13hrs

Review of partial differential equations, numerical analysis, fluid mechanics. Finite Difference Methods: Derivation of finite difference methods, finite difference method to parabolic, hyperbolic and elliptic equations, finite difference method to nonlinear equations, coordinate transformation for arbitrary geometry.

Unit II: 13hrs

Central schemes with combined space-time discretization-Lax-Friedrichs, Lax-Wendroff, MacCormack methods, Artificial compressibility method, pressure correction method – Lubrication model, Convection dominated flows – Euler equation – Quasilinearization of Euler equation, Compatibility relations, nonlinear Burger equation.

Unit III: **13hrs**

Finite Volume Methods: General introduction, Node-centered-control volume, Cell-centered-control volume and average volume, Cell-Centred scheme, Cell-Vertex scheme, Structured and Unstructured FVMs, Second and Fourth order approximations to the convection and diffusion equations (One and Two-dimensional examples).

Unit IV: **13hrs**

Finite Element Methods: Introduction to finite element methods, one-and two-dimensional bases functions – Lagrange and Hermite polynomials elements, triangular and rectangular elements, Finite element method for one-dimensional problem: model boundary value problems, discretization of the domain, derivation of elemental equations and their connectivity, composition of boundary conditions and solutions of the algebraic equations. Finite element method for two-dimensional problems: model equations, discretization, interpolation functions, evaluation of element matrices and vectors and their assemblage.

REFERENCE BOOKS

1. T. J. Chung: 'Computational Fluid Dynamics', Cambridge Univ. Press, 2003.
2. J Blazek, ' Computational Fluid Dynamics', Elsevier, 2001.
3. Harvard Lomax, Thomas H. Pulliam, David W Zingg, 'Fundamentals of Computational Fluid Dynamics', NASA Report, 2006.
4. C.A J. Fletcher: 'Computational techniques for Fluid Dynamics', Vol. I & II, Springer Verlag 1991.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT314	CO1	3	2	3	2	2		2	2	3	3
	CO2	3	2	3	2	1		2	2	3	3
	CO3	3	3	2	2	1		2	1	3	3
	CO4	3	3	2	2	1		1	2	3	3

Sub Code: **MS17MT324**	**Statistical Methods – III**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1) Distinguish between observational studies and controlled experiments.
2) Determine basic sampling schemes (simple random sampling, stratified sampling, census versus sample), their strengths and weaknesses.
3) Analyze sources of potential bias in study designs and strategies for reducing those biases. Issues include sampling and non-sampling bias, confounding lurking variables spuriousness and statistical control.
4) Interpret numerical statistics and graphical summaries of data.
5) Analyze how a study could be changed to allow conclusions about causation.

Course Outcomes:
By completing this course the student will learn to perform the following:
1. Analyse the basic concepts and application of sampling theory

2. Analyse different types of sampling methods.

3. Apply sampling theory to the area of demography

4.Apply time-series analysis concept to solve statistical problems.

UNIT – I: **13 hrs**

Basic concepts of sampling: Population, Sample, Sampling unit, Sampling frame, Complete enumeration survey, Sample Survey, Random number tables, Sampling errors, Non-sampling errors and sources, Important aspects at the planning stage of sample surveys, Role of Central Statistical Organization (CSO) and National Sample Survey Organization (NSSO).Simple random sampling with and without replacements, Estimation of population -mean, total and proportion in SRS without replacement and variances of these estimates. Determination of sample size in sampling from attribute data and variable data.

UNIT – II: **13 hrs**

Stratified random sampling, estimation of population – mean, total, proportion and variances of these estimates, Allocation problems in stratified sampling, Gain in precision due to stratification. Determination of sample size in proportional and Neyman allocations. Systematic sampling, Variance of the estimated mean, concept of circular systematic sampling. Cluster sampling with equal cluster sizes, Variance of estimated mean, Optimum cluster size for fixed cost.

UNIT- III: **13 hrs**

Demography: Source of Demographic data, measurement of mortality: CMR, ASDR, IMR, and MMR. Fecundity and fertility. Measurement of fertility: CBR, ASFR, GFR and TFR. Production rates: NPR, GRR. Life tables: components of life table, force of mortality and expectation of life, construction of life table, uses of a life table, population projection using logistic curve.

UNIT-IV: **13 hrs**

Time Series Analysis: Components of time series, addictive and multiplicative models. Measurement of trend by moving averages and by least squares. Construction of seasonal indices by simple averages and ratio to moving averages.
Index Numbers: Introduction, price and quality IN. Construction of IN: simple and weighted methods. Tests for consistency of IN, CPI, problems involved in the construction of general and CPI numbers. Uses and Limitations.

Recommended Books:
1.Anderson, T.W (1983), An introduction to Multivariate Statistical Analysis, Wiley, 2nd Edition.
2.Rao, C.R (1973), Linear Statistical Inference and its applications, 2nd edition, Wiley
3.Srivastava. M.S and Khatri, C.G (1979), An introduction to Multivariate Statistics, North Holland

4.Morrison,F(1985): Multivariate Statistical Methods, Mc Graw Hill Book Company.
5.Johnson A.R and Wishern, D.W (1996), Applied Multivariate Statistical Analysis, Prentice Hall of India
6.Sharma, S (1996), Applied Multivariate Techniques, Wiley.
7.Krishisagar, A.M (1972), Multivariate Analysis, Marcel Dekker
8.K.C. Bhuyan(2005): Multivariate Analysis and its Applications, Central

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT324	CO1	3	2	2	2			1	1	3	3
	CO2	3	1	1	2	2		1	2	3	3
	CO3	3	2	1	2	1		2	2	3	3
	CO4	3	2	1	2	1		1	2	3	3

IV Semester

Sub Code: **MS17MT411**	**CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. To understand the concept of integral equations.
2. To understand and solve the applications related problems such as classical mechanics and differential equations.

Course Outcomes:

1. Apply the Euler's equation to solve geodesics and Brachistochrone problem with boundary conditions.
2. Analyse different types of advanced variational problems.
3. Analyze the concepts of linear integral equations with applications.
4. Apply different methods of solution of linear integral equations

Unit-I **13hrs**

Euler equations and variationalnotations: Maxima and minima, method of Lagrange multipliers, the simplestcase, Euler equation, extremals, stationary function, geodesics,Brachistochrone problem, natural boundary conditions and transitionconditions, variational notation, the more general case.

Unit-II **13hrs**

Advanced variational problems: Constraints and Lagrange multipliers, variable end points, Sturm-Liouville problems, Hamilton's principle, Lagrange's equation, theRayleigh-Ritz method.

Unit-III **13hrs**

Linear integral equations: Definitions, integral equation, Fredholm and Volterra equations,kernel of the integral equation, integral equations of different kinds,relations between differential and integral equations, symmetrickernels, the Green's function.

Unit-IV **13hrs**

Methods for solutions of linearintegral equations: Fredholm equations with separable kernels, homogeneous integralequations, characteristic values and characteristic functions ofintegral equations, Hilbert-Schmidt theory, iterative methods forsolving integral equations of the second kind, the Neumann series.

Reference Books:

1. F.B. Hildebrand, Methods of Applied Mathematics, New York:Dover, 1992.
2. B. Dacorogna, Introduction to the Calculus of Variations,London: Imperial College Press, 2004.
3. F. Wan, Introduction to the Calculus of Variations and ItsApplications, New York: Chapman/Hall, 1995.
4. J. Jost and X. Li-Jost, Calculus of Variations, Cambridge:Cambridge University Press, 1998.
5. R.P. Kanwal, Linear Integral Equations: Theory andTechniques, New York: Birkhäuser, 2013.
6. C. Corduneanu, Integral Equations and Applications,Cambridge: Cambridge University Press, 2008.
7. A.J.Jerry, Introduction to Integral Equations with Applications,2nd ed., New York, John Wiley & Sons, 1999.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT411	CO1	3	2	2	1			1	1	3	3
	CO2	3	2	1	1	1			1	3	3
	CO3	3	2	2		2		1	1	3	3
	CO4	3	1	1	2			1	1	3	3

Sub Code: **MS17MT421**	**MEASURE THEORY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Students will gain an understanding of the Lebesgue measure in limit, sets, and functions.
2. Students will study the Lebesgue integration on measurable functions and measurable non negative functions.
3. Students will study the Lebesgue integration on monotone functions, differentiation of monotone functions, and absolutely continuous functions.
4. Student will read and analyse the Linear space on inequalities, approximation, separations, and convex functions.

Course Outcomes:

1. Analyze the concept of Lebesgue measurable theory for sets and functions.

2. Apply the concept of Lebesgue Integration for Riemann Integrals, the general Lebesgue integral and convergence.

3. Apply the concept of Lebesgue integration for monotone function, differentiation of monotone function and integral derivatives.

4. Analyze the concept of linear space in different theorem, sequential convergence, compactness, and minimization of convex functional.

Unit-I: **13hrs**

Lebesgue Measure: Lebesgue Outer Measure, The s-Algebra of Lebesgue measurable Sets, Outer and Inner Approximation of Lebesgue Measurable Sets,Countable Additivity, Continuity and the Borel-Cantelli Lemma, Nonmeasurable Sets, The Cantor Set and the Canton-Lebesgue Function,

Unit-II: **13hrs**

Sums, Products and Compositions of Lebesgue Measurable Functions, Sequential Pointwise Limits and Simple Approximation, Littlewood's three principles, Egoroff's Theorem and Lusin's Theorem.

Unit III: **13hrs**

The Lebesgue Integration

The Riemann Integral; The Lebesgue Integral of a Bounded Measurable Function over a Set of Finite Measure, The Lebesgue Integral of a Measurable Nonnegative Function; The General Lebesgue Integral; Countable Additivity and Continuity ofIntegration, Uniform Integrability, Uniform Integrability and Tightness, Convergence in measure, Characterizations of Riemann and Lebesgue Integrability.

Unit IV: **13hrs**

Differentiation and Lebesgue Integration: Continuity of Monotone Functions, Differentiation of Monotone Functions, Functions of Bounded Variation, Absolutely Continuous Functions, Integrating Derivatives.

Reference Books:

1. Springer, 2014. M.E. Munroe, "Introduction to measure and integration" Addison Wesley, 1959.
2. G. de Barra, "Measure theory and integration", New Age, 1981.
3. P.K. Jain and V.P. Gupta, "Lebesgue measure and integration", New Age, 1986.
4. F. Morgan, "Geometric measure theory – A beginner's guide", Academic Press, 1988.
5. F. Burk, "Lebesgue measure and integration: An introduction", Wiley, 1997.
6. D.H. Fremlin, "Measure theory", Torres Fremlin, 2000.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT421	CO1	3	1	2	1	2		2	2	3	3
	CO2	3	1	2	2	1		1	2	3	3
	CO3	3	2	2	1	1		2	2	3	3
	CO4	3	2	2	1	1		2	2	3	3

Sub Code: **MS17MT402**	**NUMERICAL ANALYSIS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs.
2. The course will further develop problem solving skills.
3. Derive appropriate numerical methods to solve a linear system of equations.

Course Outcomes:

1. Solve the non-linear equations in one variable using different numerical techniques
2. Analyze the different types of interpolation methods
3. Analyze the different types of errors and stability methods.
4. Solve partial differential equations using various numerical methods

Unit-I: **13hrs**

Numerical Solutions of Nonlinearsystem of Equations: Fixed points for functions of several variables, Newton's Method,Quasi-Newton methods, Homotopy and Continuation Methods.

Unit-II

13hrs

Initial value problems for OrdinaryDifferential Equations: Solution by Runge-Kutta Fehlberg method, Runge-Kutta- Gillmethod. Solutions of higher order differential equations and systemof differential equations by Runge-Kutta methods.

Unit-III **13hrs**

Boundary value problems for OrdinaryDifferential Equations: Linear Shooting method, Shooting method for nonlinear Problems,Finite –difference methods for non-linear problems, Rayleigh-Ritz method.

Unit-IV **13hrs**

Modern methods for linear andnon-linear differential equations: Homotopy Perturbation method and Differential Transformsmethods.

Reference Books:

1. Richard L. Burden and J. Douglas Faires, Numerical Analysis,Fourth Edition, P.W.S. Kent Publishing Company, 2007.
2. S. J. Liao, Beyond Perturbations, 2. CRC Press, 2003.
3. R.L. Burden and J. Douglas Faires, Numerical Analysis, FourthEdition, P.W.S. Kent Publishing Company, 2007.
4. S.C. Chopra and P.C. Raymond, Numerical methods forengineers, Tata McGraw-Hill, 2000.
5. C.F. Gerald and P.O. Wheatley, Applied numerical methods,Pearson Education, 2002.
6. L. C. Andrews, and R. L. Philips, Mathematical Techniques forEngineers and Scientists, Prentice Hall of India, 2006.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT402	CO1	3	2	2	2	1	1		1	3	3
	CO2	3	1	2	1	2	1		1	3	3

	CO3	3	2	2	1	2		1	1	3	3
	CO4	3	1	2	1	1		2	1	3	3

Sub Code: **MS17MT403**	**Operations Research**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. To appropriately formulate sequencing problem for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Sequencing problems.
2. To appropriately formulate Integer Programming models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these IP problems.
3. To appropriately formulate Queuing models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Queuing problems.
4. To interpret and apply the results of an operations research model.
5. To communicate the results of an operations research project through a written report and an oral presentation.

Course Outcomes:

A student must demonstrate the ability to:

1. To apply the concepts of linear programming technique to solve system of linear equations.
2. Analyze different types of Integer programming problems (IPP)
3. Apply the concepts of LPP and IPP to solve game theory problems.
4. Analyze the concepts of probabilistic distribution queuing theory

.**Unit I:** **13 hrs**

Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.

Unit II: **13 hrs**

INTER PROGRAMMING PROBLEMS: Introduction, Importance of IPP, Applications of IPP, Methods of IPP – Cutting Method. Mixed Integer Programming Problems, Branch and Bound Methods.

Unit III: **13 hrs**

Game Theory: The formulation of two persons, zero sum games, solving simple games- a prototype Example, games with mixed strategies, graphical solution procedure, and dominance rule, odd's method.

Sequencing Problems: Introduction, Definition, n-Jobs through 2-Machines, n-Jobs through 3-Machines, n-Jobs through k-Machines, 2-Jobs through k-Machines.

Unit IV: **13 hrs**

Queueing Theory : Essential Features of Queueing System - Operating Characteristic of Queueing System - Probabilistic Distribution in Queueing Systems - Classification of Queueing Models - Solution of Queueing Models - Probability Distribution of Arrivals and Departures.

Reference Books

1. J. K. Sharma, *Operations Research* Theory and Applications, Third Edition (2007), Macmillan India Ltd.
2. F.S. Hillier and J.Lieberman -,*Introduction to Operations Research* (8th Edition), Tata McGraw Hill Publishing Company, New Delhi, 2006.
3. Beightler. C, D.Phillips, B. Wilde, *Foundations of Optimization* (2nd Edition) Prentice Hall Pvt Ltd., New York, 1979
4. Bazaraa, M.S; J.J.Jarvis, H.D.Sharall, *Linear Programming and Network flow,* John Wiley and sons, New York 1990.

5. Gross, D and C.M.Harris, *Fundamentals of Queueing Theory*, (3rd Edition), Wiley and Sons, New York, 1998.
6. Hamdy A. Taha ,*Operations Research* (sixth edition), Prentice - Hall of India Private Limited, New Delhi.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT403	CO1	3	2	2	2	1	1		1	3	3
	CO2	3	1	2	1	2	1		1	3	3
	CO3	3	2	2	1	2		1	1	3	3
	CO4	3	1	2	1	1		2	1	3	3

Sub Code: **MS17MT414**	**MATHEMATICAL METHODS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:
1. The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs.
2. The course will further develop problem solving skills.
3. Derive appropriate numerical methods to solve a linear system of equations.

Course Outcomes:
1. Apply various transforms to solve typical mathematical problems.
2. Apply the integral equations to solve IVP, BVP and eigen value problems.
3. Solve problems related with asymptotic expansions.
4. Adapt regular, singular perturbation and irregular singular perturbation methods to solve differential equations.

Unit I: 13 hrs

Integral Transforms**:** General definition of Integral transforms, Kernels, etc. Development of Fourier integral, Fourier transforms – inversion, Illustration on the use of integral transforms, Laplace, Fourier, Hankel and Mellin transforms to solve ODEs and PDEs - typical examples. Discrete orthogonality and Discrete Fourier transform. Wavelets with examples, wavelet transforms.

Unit II: 13 hrs

Integral Equations: Definition, Volterra and Fredholm integral equations. Solution by separable kernel, Neumann's series resolvent kernel and transform methods, Convergence for Fredholm and Volterra types. Reduction of IVPs BVPs and eigenvalue problems to integral equations. Hilbert Schmidt theorem, Raleigh Ritz and Galerkin methods.

Unit III: 13 hrs

Asymptotic expansions : Asymptotic expansion of functions, power series as asymptotic series, Asymptotic forms for large and small variables. Uniqueness properties and Operations. Asymptotic expansions of integrals; Method of integration by parts (include examples where the method fails), Laplaces method and Watson's lemma, method of stationary phase and steepest descent.

Unit IV: 13 hrs

Regular and singular perturbation methods: Parameter and co-ordinate perturbations. Regular perturbation solution of first and second order differential equations involving constant and variable coefficients. Include Duffings equation, Vanderpol oscillator, small Reynolds number flow. Singular perturbation problems, Matched asymptotic expansions, simple examples. Linear equation with variable coefficients and nonlinear BVP's. Problems involving Boundary layers. Poincare – Lindstedt method periodic solution. WKB method, turning points, zeroth order Bessel function for large arguments, solution about irregular singular points.

REFERENCE BOOKS

1. I.N. Sneddon – The use of Integral Transforms, Tata Mc Graw Hill, New Delhi, 1974.
2. R.P. Kanwal: Linear integral equations theory and techniques, Academic Press, New York, 1971.
3. C.M. Bender and S.A. Orszag – Advanced mathematical methods for scientists and engineers, Mc Graw Hill, New York, 1978.
4. H.T. Davis – Introduction to nonlinear differential and integral equations, Dover Publications, 1962.
5. A.H. Nayfeh – Perturbation Methods, John Wiley & sons New York, 1973
6. Don Hong, J. Wang and R. Gardner. Real analysis with introduction to wavelets and applications, Academic Press Elsevier (2006)

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT414	CO1	3	2	2	1	2		1	2	3	3
	CO2	3	2	2	1	1		1	2	3	3
	CO3	3	2	1	2	1		1	2	3	3
	CO4	3	2	2	1	2		2	2	3	3

Sub Code: **M17T424**	**DIFFERENTIAL GEOMETRY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1.To understand the basic concepts of geometry of curves and surfaces in Euclidean space.
2. To familiarize with the quantities of some geometric interest.
3. To familiarize with calculus on surfaces.
4. To understand the concept of curvatures and special curves in a surface

Course Outcomes:

1) Discuss the basic concepts of geometry of curves and surfaces in Euclidean space.
2) Discuss properties and geometric interpretation of some quantities.
3) Explain calculus on surfaces.
4) Apply computational techniques for the curvatures and special curves in a surface.

Unit I: 13hrs

Calculus on Euclidean Space: Euclidean space. Natural coordinate functions. Differentiable functions. Tangent vectors and tangent spaces. Vector fields. Directional derivatives and their properties. Curves in E3. Velocity and speed of a curve. Reparametrization of a curve. 1-forms and Differential forms. Wedge product of forms. Mappings of Euclidean spaces. Derivative map.

Unit II: 13hrs

Frame Fields**:**Arc length parametrization of curves. Vector field along a curve. Tangent vector field, Normal vector field and Binormal vector field. Curvature and torsion of a curve. The Frenet formulas Frenet

approximation of unit speed curve and Geometrical interpretation. Properties of plane curves and spherical curves. Arbitrary speed curves. Cylindrical helix Covariant derivatives and covariant differentials. Cylindrical and spherical frame fields. Connection forms. Attitude matrix. Structural equations. Isometries of E3 - Translation, Rotation and Orthogonal transformation. The derivative map of an isometry.

Unit III: 13hrs

Calculus on a Surface: Coordinate patch. Monge patch. Surface in E3. Special surfaces- sphere, cylinder and surface of revolution. Parameter curves, velocity vectors of parameter curves, Patch computation. Parametrization of surfaces- cylinder, surface of revolution and torus. Tangent vectors, vector fields and curves on a surface in E3. Directional derivative of a function on a surface of E3. Differential forms and exterior derivative of forms on surface of E3. Pull back functions on surfaces of E3.

Unit IV: 13hrs

Shape Operators: Definition of shape operator. Shape operators of sphere, plane, cylinder and saddle surface. Normal curvature, Normal section. Principal curvature and principal direction. Umbilic points of a surface in E3. Euler's formula for normal curvature of a surface in E3. Gaussian curvature, Mean curvature and Computational techniques for these curvatures. Minimal surfaces. Special curves in a surface of E3 - Principal curve, geodesic curve and asymptotic curves. Special surface - Surface of revolution.

REFERENCE BOOKS:

1. Barrett O' Neil : Elementary Differential Geometry. Academic Press, New York and London, 1966
2. T.J.Willmore : An introduction to Differential Geometry. Clarendon Press, Oxford 1959.
3. D.J.Struik : Lectures on Classical Differential Geometry, Addison Wesley, Reading, Massachusetts, 1961.
4. Nirmala Prakassh: Differential Geometry- an integrated approach. Tata McGraw-Hill, New Delhi, 1981.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT424	CO1	3	2	2	1	1	1	1	1	3	3
	CO2	3	2	1			1			3	3
	CO3	3	2	2	1	2		2	1	3	3
	CO4	3	2	2	2	1	1	1	2	3	3

Sub Code: **MS17MT416**	**FUZZY SET AND FUZZY LOGIC**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Students will study the fuzzy sets, basic operation on fuzzy sets, inverse and image fuzzy operations.
2. Students will study fuzzy relation and fuzzy graph
3. Student will read and analyse the fuzzy sets and fuzzy logic on possibility theory and probability theory.

Course Out comes:

At the end of the course, students should:

1. Analyze the concept of fuzzy set and fuzzy logic using fuzzy operations.
2. Apply the fuzzy operations on functions, relations and fuzzy graph.
3. Analyze possibility theory, fuzzy measure and possibility theory verses probability theory.
4. Apply the operation of fuzzy sets on fuzzy reasoning, fuzzy system and pattern recognition.

Unit - I: **13 hrs**

Fuzzy sets - Basic definition a -level sets. Convex fuzzy sets. Basic operations Fuzzy sets. Type of Fuzzy sets. Cartesian products. Algebraic products. Bounded sum and difference t-norms and t-conorms. The extension Principle- The Zadeh's extension principle image and inverse image of Fuzzy arithmetic.

Unit - II: **13 hrs**

Fuzzy Relation and Fuzzy Graphs-Fuzzy equivalence equations. Fuzzy graphs, Similarity relation.

Unit - III: **13 hrs**

Possibility theory-Fuzzy measures, Evidence theory necessity measure, Possibility theory versus probability theory.

Unit-IV: **13 hrs**

Constructing Fuzzy sets and operations on Fuzzy sets. Approximate reasoning. Fuzzy System. Pattern Recognition

Reference Books:

1. Fuzzy set theory and its application allied publisher rd New Delhi - 1991 - U. Z. Zimmermann
2. Fuzzy set and fuzzy logic prentice Hall of Indi New Delhi 1995- G J Klir& Bo Yuan
3. Fuzzy logic in Engineering applications by Timothy J Ross Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems by Guanrong Chen, Trung Tat Pham

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2

MS17MT416	**CO1**	3	2	2	1	1	1	1	1	3	3
	CO2	3	2	1			1			3	3
	CO3	3	2	2	1	2		2	1	3	3
	CO4	3	2	2	2	1	1	1	2	3	3

Sub Code: **MS17MT426**	**Advanced Graph theory**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Outcomes

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

1. a. Analyze the concept of matching to estimate the bond lengths.
   b. Analyze the concept of matching to solve TSP.
2. a. Connect the concept of connectivity to solve utility problems, mapping problems.
   b. Connect the concept of planarity to solve 2D circuit problem (minimizing the number of intersection of wires).
3. Connect the concept of domination to solve routing problem, locating radar station problem.
4. Analyze and connect the concept of colorability to solve Sudoku problem, mobile frequency assignment problem.

Module – 1 Matchings and Factors **15 Hrs**

Matching, Maximum Matchings, Hall's Matching Condition, Hall's Theorem, Min – Max Theorem, Independent Sets and Covers, Maximum Bipartite Matching, Weighted Bipartite Matching, Tutte's 1- Factor Theorem, Partition – Degree Sequence, Havel's and Hakimi Algorithms and graphical related problems.

Module – 2 Advanced Digraph theory **14 Hrs**

Acyclic Digraph, Multipartite Digraphs, Transitive Digraphs, Line Digraphs, Series-Parellel Digraphs, Quasi-Transitive Digraphs, Path-Mergeable Digraphs, Locally Semicomplete Digraphs, Planar Digraphs.

Module – 3 Domination in Graphs **13 Hrs**

Domination in Graphs, Bounds in terms of order, Bounds in terms of size, Bounds interms of Degree, Diameter and Girth, Bounds in terms of Independence and Covering, Domatic Number.

Module – 4 Chromatic Graph Theory **10 Hrs**

T – Colorings, L(2,1)-Colorings, Radio Colorings, Hamiltonian Colorings, Domination and Colorings(aplications).

Text Books and Reference

1. D. B West, Introduction to Graph Theory, New Delhi, Prentice – Hall of India, 2011.
2. T.W. Haynes, S.T. Hedetniemi and P.J. Slater, Fundamentals in Domination in Graphs, New York: Dekker, Inc., 1998
3. J.. Bang – Jensen and G. Gutin, Digraphs. London: Springer,2009.
4. G. Charrtand and P. Zhang, Chromatic Graph Theory, New York: CRC Press, 2009

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT426	CO1	3	2	2	1	1	1	1	1	3	3
	CO2	3	2	1			1			3	3
	CO3	3	2	2	1	2		2	1	3	3
	CO4	3	2	2	2	1	1	1	2	3	3

Sub Code: **MS17MT307**	**Optimization Techniques**	C	L	T	P	CH
Duration: 14 Weeks		4	0	0	0	4

Course Objectives:

1. To learn engineering applications and formulation of optimization problems.
2. To learn various optimization techniques.
3. To learn the geometry and standard form of linear programming problems.
4. To learn various methods of non-linear programming to compute structural engineering problems.
5. To learn geometric and dynamic programming
6. To formulate and obtain the solution of structural optimization problems by different techniques.

Course Outcomes: At the end of the course, the student

1. Has learnt engineering applications and formulation of optimization problems
2. Has learnt various optimization techniques
3. Has learnt the geometry and standard form of linear programming problems
4. Has learnt various methods of non-linear programming to compute structural engineering problems.

Course Contents:

Unit 1

Introduction: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems.

Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.

Unit 2

Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.

Unit 3

Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods. Constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems.

Unit 4

Game Theory:

The formulation of two persons, zero sum games, solving simple games- a prototype Example, games with mixed strategies, graphical solution procedure, and dominance rule, odd's method.

Sequencing Problems:

Introduction, Definition, n-Jobs through 2-Machines, n-Jobs through 3-Machines, n-Jobs through k-Machines, 2-Jobs through k-Machines.

Structural Optimization and Geometric programming: Geometric programming, conversion of NLP as a sequence of LP/ geometric programming

Reference Books:

1. S.S Rao, **"Optimization – Theory and Practice"** – Wiley Eastern Ltd.
2. Uri Krisch, **"Optimum Structural Design"** – McGraw Hill.
3. Richard Bronson, **"Operation Research"** – Schaum's Outline Series.
4. Bhavikatti S S, **"Structural Optimization using sequential linear Programming"** – Vikas Publishing House.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT307	CO1	3	3	2	1	1	1	1	1	3	3
	CO2	3	2	1			1			3	2
	CO3	3	3	2	1	2		2	1	3	2
	CO4	3	2	2	2	1	1	1	2	3	3

Sub Code: **MS17MT308**	**CRYPTOGRAPHY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

To know the methods of conventional encryption.

1. To understand the concepts of public key encryption and number theory
2. To understand authentication and Hash functions.
3. To know the network security tools and applications.
4. To understand the system level security used.

Course Outcomes:

1. Understand the principles and practices of cryptographic techniques.
2. Understand the theory of fundamental cryptography, encryption, and decryption algorithms,
3. Understand a variety of generic security threats and vulnerabilities, and identify and analyse particular security problems for a given application.
4. Build simple cryptosystems by applying encryption algorithms and Comprehend secure identity management (authentication), message authentication, and digital signature techniques.

Unit-I **13hrs**

INTRODUCTION

OSI Security Architecture - Classical Encryption techniques – Cipher Principles – Data Encryption Standard – Block Cipher Design Principles and Modes of Operation - Evaluation criteria for AES – AES Cipher – Triple DES – Placement of Encryption Function – Traffic Confidentiality

Unit-II **13hrs**

PUBLIC KEY CRYPTOGRAPHY

Key Management - Diffie-Hellman key Exchange – Elliptic Curve Architecture and Cryptography - Introduction to Number Theory – Confidentiality using Symmetric Encryption – Public Key Cryptography and RSA.

Unit-III **13hrs**

AUTHENTICATION AND HASH FUNCTION

Authentication requirements – Authentication functions – Message Authentication Codes – Hash Functions – Security of Hash Functions and MACs – MD5 message Digest algorithm - Secure Hash Algorithm – RIPEMD – HMAC Digital Signatures – Authentication Protocols – Digital Signature Standard

Unit-IV **13hrs**

SYSTEM LEVEL SECURITY

Intrusion detection – password management – Viruses and related Threats – Virus Counter measures – Firewall Design Principles – Trusted Systems.

Reference Books:

1. William Stallings, "Cryptography And Network Security – Principles and Practices", Pearson Education, 2011

2. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill, 2003.

3. Bruce Schneier, "Applied Cryptography", John Wiley & Sons Inc, 2001.

4. Charles B. Pfleeger, Shari Lawrence Pfleeger, "Security in Computing", Third Edition, Pearson Education, 2003.

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MS17MT308	CO1	3	2	2	1	1	1	1	1	3	2
	CO2	3	2	1			1			3	3
	CO3	3	3	2	1	1		2	1	3	2
	CO4	3	2	2	2	1	1	1	2	3	3

CAREER OPPURTUNITIES

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:

1. Willingness to learn
2. Self motivation
3. Team work
4. Communication skills and application of these skills to real scenarios
5. Requirement of gathering, design and analysis, development and testing skills
6. Analytical and Technical skills
7. Computer skills
8. Internet searching skills
9. Information consolidation and presentation skills
10. Role play
11. 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 improves 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 Mathematics is not only the knowledge in the subject, but also the skill to do the job proficiently, team spirit and 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, 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 School of Applied sciences also has emphasised subject based skill training through lab practice, internship, project work, industry interaction and many such skilling techniques. The students during their

day to day studies are made to practice these skill techniques as these are inbuilt in the course curriculum. Concerned teachers also continuously guide and monitor the progress of students.

The University has also established University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director 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 University has also 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.

Rukmini Knowledge Park
Kattigenahalli, Yelahanka,
Bengaluru – 560064, INDIA

Tel : +91 80 4696 6966
Fax : +91 80 4696 6998

www.reva.edu.in