CURRICULUM
&
SYLLABUS
B.Sc. Program (Mathematics)



ICFAI Foundation for Higher Education
(Deemed-to-be University under Section 3 of the UGC Act, 1956)

IcfaiTech
Faculty of Science & Technology (FST

ICFAI FOUNDATION FOR HIGHER EDUCATION ★ HYDERABAD

REGISTRAR
ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deemed-to-be-University establishes under section 3 of UGC Act 1956.)

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1. INTRODUCTION

1.1 The ICFAI Foundation for Higher Education

The ICFAI Foundation for Higher Education (IFHE) is declared as a Deemed-to-be University, under Section 3 of the UGC Act, 1956. It has evolved a comprehensive student-centric learning approach consisting of several stages, designed to add significant values to the learner's understanding in an integrated manner, covering relevant knowledge, practical skills and positive attitudes. IFHE comprises of:

- Faculty of Management (IBS Hyderabad),
- Faculty of Science and Technology (IcfaiTech), and
- Faculty of Law (FoL).

Vision and Mission of IFHE

The Vision of IFHE is to emerge as an Institution of Excellence known for research, teaching and practice.

The Mission of IFHE is 'Learning for Leadership'. It aims at developing a cadre of professionals possessing specialized skills having a sense of social and moral responsibility and the ability to address problems from a broader perspective.

1.2 Faculty of Science and Technology (IcfaiTech)

Faculty of Science and Technology (IcfaiTech), Hyderabad is a constituent of the ICFAI Foundation for Higher Education. It has been established to promote quality education in the field of Science andTechnology. IcfaiTech strives to acquire a reputation as a highly purposive, innovative institution setting the pace for workable reforms in professional education suitable and most relevant for the Indian cultural milieu.

VISION

The IcfaiTech campus shall become a leading institute for scientific research as well as innovative teaching and learning, keeping pace with evolving knowledge domains. It shall emerge as an attractive destination for the excellent students and the faculties. IcfaiTech aspires to be highly ranked amongst the group of other peer institutes.

MISSION

The mission of the IcfaiTech is to provide high quality teaching and learning experience through our first degree and higher degree programs.

• Teaching Excellence: IcfaiTech periodically reviews and redesigns existing courses and introduces new courses and programs geared towards current research and industry. It explores new dimensions in teaching and learning and uses various platforms and methodologies.

• Research Excellence: The faculty members of the department carry out research in almost all the major areas. The department is now vigorously scaling up its research activity and giving more visibility to it. The volume of research publications in peer reviewed journals of repute and the research funding received by the department has been increasing steadily.

• Faculty Leadership in Administration: The faculty members of the department make significant contribution to administrative leadership and various institute activities and initiatives.

1.3 Educational Philosophy

The core philosophy of education at IcfaiTech is empowering students with the right knowledge and modern skill sets in order that they are ready to face the challenges of the competitive world. IcfaiTech strives to provide its students with the fine edge that is required in the making of a successful professional. The programs at IcfaiTech have been uniquely designed by including courses drawn from varied areas like humanities, arts, and management combined with science, engineering and industry-based internships. IcfaiTech ensures that students gain exposure and knowledge across different disciplines, develop inter-personal skills and leadership qualities that takes them beyond traditional thinking and practice. Today's era

of globalization and integrated economies presents talented professionals huge opportunities from across the world. The curriculum at IcfaiTech is truly global and modern in perspective and exposes its students to the latest practices and techniques. The curriculum offers a cafeteria approach allowing them to choose courses from across the disciplines. This exposure also helps them to develop interests in tune with the current inter-disciplinary nature of research. The educational philosophy practices at IcfaiTech allows it to integrate into its learning system, an innovative and emerging body of knowledge. The highlights of the academic program are summarized below:

• Cutting-edge course curriculum with contemporary and effective pedagogic methods that lay emphasis on application-oriented learning.

• Encouraging students to not only articulate Science and Technology needs but also provide appropriate solutions.

• Developing appreciation for synthesized multidisciplinary learning by way of workshops, internships and other group learning assignments.

1.4 Objectives of IcfaiTech

• To provide high quality, cutting-edge and career-oriented education programs in Science and Technology.

• To offer practice-oriented, contemporary and flexible programs developed through regular assessment and consultation with leading institutions, academicians, professionals and practitioners.

• To turn out highly motivated and successful Science and Technology graduates to meet the current and projected needs of the knowledge workforce.

1.5 Flexibilities

A few of the flexibilities available to the students are mentioned below. The principle of merit, preference of the students and the facilities available at the Institute generally guide the decisions regarding flexibilities. Transfer: Every year, various branches of engineering are ranked based on the preferences and demands of the admitted batch of students. After two semesters of study (end of the first year), students can seek transfer across branches. Requests from students seeking transfer from a less preferred branch to the most preferred branch of B.Tech would be considered if they maintain a CGPA of not less than 9.00, by the end of the first year of degree program. For a branch transfer to the second most preferred branch, a

student should have a CGPA of not less than 7.00 by the end of the first year of degree program. A branch transfer from a more preferred branch to a less preferred branch would be permitted without any restrictions on CGPA. Audit: Over the years of study at IcfaiTech, a student may develop interest in areas that go beyond the scope of his/her program of studies. IcfaiTech permits students to take such courses as audit courses. Certain courses like Foreign Languages, Music, etc. which are not the part of a degree program could be opted for on an audit basis, on payment of additional fees. Audit courses do not count for the CGPA calculation.

Other Flexibilities: The Academic Regulations also provide flexibilities like choice of electives, number of electives, repetition of courses, departure from normal pace, withdrawal from or substitution of course(s).

1.6 Admissios at IcfaiTech:

Admission Test for IcfaiTech (ATIT) is an All India Admission Test conducted by IcfaiTech, IFHE, Hyderabad for students seeking admission into the 4 year Integrated B.Tech. Programs and 3 year Integrated B.Sc Programs.

ATIT 2020 is an aptitude test conducted through online & offline tests constitute objective type questions in Mathematics, Physics, Chemistry, English and logical reasoning in multiple choice format. Question paper pattern is given below and syllabus given in website www.ifheindia.org/icfaitech.

Eligibility for admission into the B.Tech/BSc Program:

- Pass with 60% and above aggregate marks in Class XII ("or its equivalent") with Mathematics, Physics, Chemistry and English as subjects.

- Class XII (or icfaitech equivalent) students awaiting final examination results may also apply.

- Applicants should have completed 12 years of formal schooling in order to apply for the program.

- The applicant should fulfil the minimum age requirements as prescribed by the respective Board through which the applicant has appeared for the qualifying examination.

1.7 Programs at IcfaiTech

At IcfaiTech, the programs offered are divided into three tiers, namely the first degree programs, the higher degree programs and the doctoral programs falling into the first, second and the third tiers respectively. All the undergraduate, integrated programs fall under the first degree programs. The various masters programs fall under the category of the higher degree programs. The Ph.D. programs offered by various departments fall under the category of doctoral programs. The academic structures of each of these programs are discussed below.

First Degree Programs (First Tier)

There are three first degree programs being offered at IcfaiTech, the details of which are available in the prospectus/view book. Without going into the details of the regulatory processes, it is necessary to touch upon the subject to obtain a better understanding of these processes, which are controlled by these regulations in respect to operation.

There may be some restrictions from time to time in terms of flexibilities like transfer or dual degree concerning these degree programs. This will be notified in the prospectus/view book as per periodic decision of the Academic Council. All operational matters concerning this will be controlled by the PGC.

Program Courses

The various courses prescribed for a program of study may be categorized in terms of their academic affinity or their functional objectives. Depending on overall educational goals of programs, it is possible to have fixed named courses in a particular category, to have fixed number of electives; to have a range of named courses in a particular category and to have a number of electives within a range. Named courses are those indicated by course number and course title in the semester-wise- pattern prescribed for a program

For first degree students the named courses include all mandatory courses under the General Institutional Requirement and the Discipline Specific Core courses, known as Compulsory Discipline courses (CDCs), for the program(s). The Elective courses fall under three categories: Discipline Electives, Humanities Electives and Open Electives. Open Electives enable students to pursue courses that are neither part of the discipline requirement nor part of the humanities requirement. Normally any elective course will be treated as an Open Elective once the student's

requirement under Discipline Electives and Humanities Electives have been accounted for. Open elective requirement of Dual degree students is met by counting the Discipline Electives of one degree as Open Electives of the other degree. A first degree student may also choose, where permitted, up to a certain prescribed maximum of his/her elective courses from the offerings in the higher degree, subject to the approval by the DCA and the prerequisite requirements and clause 3.18 regarding over preparedness and under preparedness. Provided that, if such a student after graduation is admitted to a higher degree program his/her total requirement in the latter cannot ipso facto be reduced.

The prior preparation required of a student who intends to choose courses from a higher degree program of the Institute for the fulfillment of his/her elective requirement(s) are given in clause 3.15.

In a program all courses outside the elective categories are defined as named courses, in view of the fact that they have already been named in the semester-wise-patterns in the prospectus/view book or have been named by an appointed authority through subsequent operation on the basis of guidelines given in the prospectus/view book .The electives are, on the other hand, selected by the student himself/herself from outside the named courses in his/her program. The intended regions where he/she goes for the search will be designated as host regions. Certain specialized courses, Internship programs, Thesis etc., These courses are named courses for some specific programs and they are debarred to other students as electives in the same way as they are debarred to students who wish to take them on audit.

For each program the number of electives, under each of the categories, required to be taken by a student will be prescribed either through the prospectus/view book or through an appropriate committee. Over and above the prescribed number of electives, a student of an integrated first degree program will be allowed to take, on his/her own option, up to a maximum number of four electives. In extraordinary cases, the number may be increased by the DCA without violating limit. For the purpose of eligibility for degree(s),a student should get valid grades in at least the prescribed number of electives – under each of the categories, of his/her program(s). The student above a particular CGPA as prescribed by ACC will be allowed to register in maximum of one higher degree course per semester. This will be counted as open elective unless the course is listed in pool of discipline electives for his/her program.

Once a first degree student is declared to have fulfilled the requirements of graduation the student may be permitted to register for at most one additional semester with prior permission of his/her

Coordinator(s)of Department and Chairperson-Academics. Any first degree student who is interested in pursuing open elective(s) above the graduation requirements and/or completing a minor program he/she is pursuing and if that necessitates overstay, he/she should obtain permission from Chairperson- Academics at least one semester before the start of the overstay period. The overstay period can be at most one semester during which the student must register for at least three new courses of at least 9 units. In case a student withdraws from one or more of his/her courses or otherwise is found not to be pursuing his/her courses in all earnestness Chairperson-Academics in concurrence with the student's department Coordinator is authorized to get him/her graduated and evacuate the student from the campus.

The structure contains a category of courses such as Internship Program (IP)/Thesis (TS), which attempts a synthesis of earlier courses and gives a glimpse of the application of these courses. They carry a large number of units and are to be pursued when student can ensure sufficient time and attention throughout the allotted period. In particular, IP components are to be pursued exclusively full time throughout the allotted period. There is no provision for taking other courses along with an IP component. In case of a Thesis a student may choose between 12 units worth of thesis work or 20 units worth of thesis work with the concurrence of his/her supervisor. A student pursuing a 20 unit thesis must pursue it exclusively full time throughout the allotted period and there is no provision for taking other courses along with it. A student pursuing a 12 unit thesis may concurrently pursue at most 3 courses (totaling at most 9 units) and will not be allowed to pursue any other course/component.

The Higher Degree Programs (Second Tier)

At higher degree level, structure of the program is classified into courses, like, Research Methods, CDCs, electives, IP and thesis. Registration for the IP can be done only after all other required courses have been completed.

In the case of thesis, while normal registration can be done only after completion of all other courses, in extraordinary cases, the DCA may allow registration in Dissertation, spread over various semesters, along with other courses. A student of higher degree program can register up to a maximum of one elective more than those prescribed in a semester. This additional elective can be from the pool of electives of the concerned degree or named/electives courses from other disciplines' with the permission of DCAs – namely the DCA of the student's Department and the DCA of the Department offering the course that the student wants to pursue. The grade obtained in such additional electives will also be counted towards the CGPA. Each course in the Core

Requirement or in the List of Electives must be a graduate level (5th or 6th level) course or an advanced under-graduate course (4th level) with the restriction that a student may use at the most two 4th level courses to meet the requirements in above.

Ph. D Program (Third Tier)

The Ph.D. program is designed for the student to achieve a broad competence before research begins. He/she is required to clear certain course work, if not already cleared, and pass the Qualifying Examination to satisfy the institute that his/her spectrum of knowledge is such as to enable him to undertake the demands of interdisciplinary research. Working knowledge of a modern European language, wherever specified, Teaching Practice, Independent Study, Research Methodology and specified units of Thesis course and Seminar are significant components of the Ph.D. program. The pursuit of research through the Thesis-Seminar course will continue and terminate in a thesis which meets the standards and requirements of the committee of scholars.

1.8 . The Academic Year

At IcfaiTech, the academic year is divided into two semesters (First Semester and the Second Semester) and a term called Summer Term. Each semester is of 18 weeks duration and summer term of 8 weeks duration. There are eight semesters during the four year B.Tech program. After completing the first four semesters, the students undertake an Internship Program (IP-1) for two months. During the final year, students go for five and half month's duration Internship Program-II (IP-II) in either of the two semesters and the adjoining summer term. Instead of the Internship Programs, a student can opt for Thesis/Seminar in the final year.

Structure of B.Tech Program

The program of studies leading to the award of a B.Tech degree consists of the prescribed courses sequentially distributed over the required number of semesters known as Semesterwise pattern.

The program is planned in such a way that in the normal course, a student will complete the program in 8 semesters. Categorization of Courses The courses are categorized as

- Basic Sciences Courses
- Analysis Oriented Courses
- Engineering Science Courses
- Humanities Courses
- Technical Art Course

Discipline Courses

Discipline Courses of the Specific branch of B.Tech Program consists of Compulsory Discipline Course (CDC) and Discipline Courses other than Compulsory (DCOC).The Compulsory Discipline Courses (CDC), twelve in number for each branch are to be completed by every student of the branch taking 2 CDCs in the second semester of the second year, and 10 CDCs in the two semesters of the third year of the Program.

Discipline Courses in the category of DCOC, may be taken as electives. A student must take up a minimum of 6 electives to earn the required credits for the completion of the program. Additionally, a student can take up to 4 optional electives. This is however not mandatory. Students can also opt for DCOCs from other branches as electives, provided he/ she completes all the prerequisites for the same.

Credits calculation

Each course in the program structure is associated with an LPU (three digits) which describes the nature of the course.The first digit denotes the number of lecture hours per week, the second digit denotes the number of practical hours per week and the third denotes the credits or units given to the course for calculation of CGPA. Wherever, a single number appears, it indicates the total number of units only; its break-up may be announced through the time table or the Course Handout.

The effort that has to be put in by a student for a course is quantified in terms of 'units'. One unit in a theory course denotes three hours per week of study. This includes one lecture hour and two hours spent towards self-study. One unit in a laboratory-based course denotes two hours per week of laboratory work and one hour of self-study.

For example, a three unit theory course requires students to work on that course for about 9 hours per week. 3 Hrs of formal contact hours/ week + 6 Hrs of self-study outside classroom/ week = 9 Hrs per week.

The eligibility for a degree is determined on the basis of number of units completed. The minimum stipulated number of units for various degree programs are given below

Integrated First Degree (First tier)

B. Tech.	172
B. Sc.	133
B. Sc. – B. Tech Degree	209
B.Tech – B.Tech Degree	243

Higher Degree (Second tier)

M. Tech	90
Ph.D. (Thesis)	40

PROGRAM EDUCATIONAL OBJECTIVES, PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Educational Objectives (PEOs):

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

Program Outcomes (POs):

Program outcomes describe what students are expected to know and would be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program.

Program Specific Outcomes (PSOs):

Program Specific Outcomes are statements that describe what the graduates of a specific engineering program should be able to do.

STATEMENTS OF PEOs, POs AND PSOs

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1-PROFESSIONAL DEVELOPMENT

To develop in the students the ability to acquire knowledge of Mathematics,Science & Engineering and apply it professionally within realistic constraintssuch as economic, environmental, social, political, ethical, health and safety,manufacturability and sustainability with due ethical responsibility.

PEO2-CORE PROFICIENCY

To provide ability to identify, formulate, comprehend, analyze, design and solve engineering problems with hands on experience in varioustechnologiesusing modern tools necessary for engineering practice to satisfy the needs ofsociety and the industry.

PEO3- TECHNICAL ACCOMPLISHMENTS

To equip the students with the ability to design, simulate, experiment, analyze,optimize and interpret in their core applications through multi disciplinaryconcepts and contemporary learning to build them into industry readygraduates.

PEO4- PROFESSIONALISM

To provide training, exposure and awareness on importance of soft skills forbetter career and holistic personality development as well as professionalattitude towards ethical issues, team work, responsiblility, accountability,multidisciplinary approach and capability to relate engineering issues tobroader social context.

PEO5- LEARNING ENVIRONMENT

To provide students with an academic environment and make them aware of excellence, develop the urge of discovery, creativity, inventiveness, leadership, written ethical codes and guidelines and the life-long learning to become a successful professional in Electronics and Communication Engineering.

PROGRAM SPECIFIC OUTCOMES (PSOs):

B.Sc. Program (Mathematics)

PSO1	Model computational problems by applying mathematical concepts and design solutions using suitable data structures and algorithmic techniques
PSO2	Design and develop solutions by following standard software engineering principles and implement by using suitable programming languages and platforms
PSO3	Develop system solutions involving both hardware and software modules

PROGRAM OUTCOMES (POs):

PO1	**Engineering knowledge**	An ability to apply knowledge of mathematics (including probability, statistics and discrete mathematics), science, and engineering for solving Engineering problems and modeling
PO2	**Problem analysis**	An ability to design, simulate and conduct experiments, as well as to analyze and interpret data including hardware and software components
PO3	**Design / development of solutions**	An ability to design a complex system or process to meet desired specifications and needs
PO4	**Conduct investigations of complex problems**	An ability to identify, formulate, comprehend, analyze, design synthesis of the information to solve complex engineering problems and provide valid conclusions.
PO5	**Modern tool usage**	An ability to use the techniques, skills and modern engineering tools necessary for engineering practice
PO6	**The engineer and society**	An understanding of professional, health, safety, legal, cultural and social responsibilities
PO7	**Environment and sustainability**	The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and demonstrate the knowledge need for sustainable development.
PO8	**Ethics**	Apply ethical principles, responsibility and norms of the engineering practice
PO9	**Individual and team work**	An ability to function on multi-disciplinary teams.
PO10	**Communication**	An ability to communicate and present effectively
PO11	**Project management and finance**	An ability to use the modern engineering tools, techniques, skills and management principles to do work as a member and leader in a team, to manage projects in multi-disciplinary environments
PO12	**Life-long learning**	A recognition of the need for, and an ability to engage in, to resolve contemporary issues and acquire lifelong learning

B.Sc. Program (Mathematics)

Year	Course Code	Semester-I	L	P	U	Course Code	Semester-II	L	P	U
I	BMCHEM 111	Chemistry	3	0	3	BMES121	Thermodynamics	3	0	3
	BMEGL112	English Language Skills	3	0	3	BMAO122	Probability &Statistics	3	0	3
	BMMATH113	Linear Algebra	3	0	3	BMMATH123	Higher calculus	3	0	3
	BMPHY114	Physics I	3	0	3	BMPHY124	Physics II	3	0	3
	BMTA115	Engineering Graphics	2	4	4	BMTA125	Scientific Measurements	0	4	2
	BMTA116	Computer Programming-I	3	0	3	BMTA126	Workshop Practice	2	4	4
	BMEVS117	Environmental Science	2	0	2	BMTA127	Computer Programming II	3	0	3
	Total No of Credits				**21**	**Total No of Credits**				**21**
II	**Semester-III**					**Semester-IV**				
	BMES211	Electrical Sciences I	3	0	3	BMES221	Electrical Sciences II	3	0	3
	BMES212	Digital Electronics	2	2	3	BMTA222	Engineering Measurements	1	8	4
	BMES213	Engineering Mechanics	3	0	3	BMTA223	Professional Communication	3	0	3
	BMECON214	Principles of Economics	3	0	3	BMMGTS224	Principles of Management	3	0	3
	BMMATH215	Complex Variables	3	0	3	BMAO225	Optimization Techniques	3	0	3
	BMMATH216	Differential Equations & Fourier Series	3	0	3	BMES226	Structure & Properties of Materials	3	0	3
	MATH211	Stochastic Process	3	0	3	MATH221	Partial differential equations & systems of ODEs	3	0	3
	Total No of Credits				**21**	**Total No of Credits**				**22**
	Summer Term Internship Program IP 221									**5**
III	**Semester-V**					**Semester-VI**				
	MATH311	Real Analysis	3	0	3	--	Humanities Electives (2)			6
	MATH312	Algebra	3	0	3					
	MATH313	Graph Theory	3	0	3	--	Electives (5)			15
	MATH314	Combinatorial Mathematics	3	0	3					
	MATH315	Cryptography	3	0	3					
	MATH316	Statistical Methods	3	2	4					
	MATH317	Differential Geometry	3	0	3					
	Total No of Credits				**22**	**Total No of Credits**				**21**
	Total No of Credits									**133**

Table : Compulsory Discipline Courses for the B.Tech Programs

Mathematics				
Course Code	**Course Title**	**L**	**P**	**U**
MATH211	Stochastic Processes	3	0	3
MATH221	Partial Differential Equations & Systems of ODEs	3	0	3
MATH311	Real Analysis	3	0	3
MATH312	Algebra	3	0	3
MATH313	Graph Theory	3	0	3
MATH314	Combinatorial Mathematics	3	0	3
MATH315	Cryptography	3	0	3
MATH316	Statistical Methods	3	2	4
MATH317	Differential Geometry	3	0	3

Electives for B.Sc. (Mathematics)

Course Code	Course Title	L	P	U
MATH323	Metric Spaces	3	0	3
MATH324	Rings and Fields	3	0	3
MATH325	Topology	3	0	3
MATH326	Advanced Probability Theory	3	0	3
MATH327	Continuum Mechanics	3	0	3
MATH328	Advanced Combinatorics	3	0	3

List of Humanities Electives

Course Code	Course Title	L	P	U
HS311	Dynamics of Social Change	3	0	3
HS312	Introduction to Psychology	3	0	3
HS313	Heritage of India	3	0	3
HS314	Modern Political Science	3	0	3
HS315	Public Administration	3	0	3
HS316	Professional Ethics	3	0	3

3. B.Sc Program (Mathematics) Course Description

Semester-wise Institute Courses

Course Code	Course Title	L	P	U	Course Description
BMCHEM111	Chemistry	3	0	3	Coordination Chemistry: Effective atomic number, Nomenclature of coordination compounds, Shapes of d-orbitals, Valence Bond Theory, Magnetism, Crystal Field Theory of Octahedral Complexes, Tetragonal distortions of Octahedral Complexes (Jahn-Teller Distortions), Square Planar and Tetrahedral Complexes, Thermodynamics-First Law: Work and Heat, Internal Energy and Enthalpy, Thermo chemistry: Enthalpy changes accompanying physical change and chemical change e.g. Thermodynamics -Second Law: Entropy and 2nd Law, The Gibb's Free Energy, Phase equilibria: Pure substances The thermodynamics of phase transition, Phase diagrams, Phase diagrams of typical materials Principles of chemical equilibria: The reaction Gibb's energy, Reactions at equilibrium, The response of equilibria to the conditions Consequences of equilibrium: Proton transfer equilibria, Salts in water, Solubility equilibria, Common ion effect Electrochemistry: The migration of ions, Electrochemical cells. The cell potential. Application of standard potentials, The rates of reactions: Empirical chemical kinetics, Reaction rates, Temperature dependence of reaction rates.
BMEGL112	English Language Skills	3	0	3	Familiarizing students with basic English sound system to enhance their power of articulation. It provides intensive practice and extensive exposure to listening, speaking, reading and writing Skills. It would enhance not only their comprehensive knowledge of vocabulary but also strengthens their all four skills. The design and content of the course are aimed at making students gain language proficiency and also improve their communication skills
BMMATH113	Linear Algebra	3	0	3	Matrices, Elementary row operations, Row and column equivalence, Row Reduced Echelon Matrices, Invertible Matrices, Gauss Jordan method to find the inverse, Solving system of linear equations (homogeneous and non-homogeneous), Vector spaces, subspaces, Bases and Dimension, and Computations of Subspaces, Linear Transformations, The Algebra of linear Transformations, Isomorphism between Matrices and Linear Transformations, Representation of Linear Transformations by Matrices, Eigen values, Eigen vectors, Diagonalization, Quadratic forms, Canonical forms.
BMPHY114	Physics I	3	0	3	Momentum and impulse; two and many particle system; Rotational kinematics and dynamics; work and energy; conservation principles; oscillations and wave motion; interference, diffraction and polarization.

Course Code	Course Title	L	P	U	Course Description
BMTA115	Engineering Graphics	2	4	4	Angle of projections; free hand sketching; orthographic views; pictorial views; auxiliary views; lines and planes; intersection and development; AutoCAD command and simple drawings using AutoCAD.
BMTA116	Computer Programming I	3	0	3	Basics of Problem solving, Solve with an example, Introduction to python, Data Types, Python Program Flow Control, Python Sequences, Python Functions, Python Modules, Python Packages, Python Object Oriented Programming, Exception Handling, My First Cloud Program - Powered by AWS (Cloud Inventor) :Overview of computer and internet, Introduction and basics of cyber security, General idea of data analysis, Basics of programming and algorithms, Overview of computing, Introduction to cloud computing, Overview of cloud models, General idea of cloud computing, Problem solving – Case Study
BMEVS117	Environmental Science	2	0	2	Meaning of Environment, Types and components of environment, nature and scope of the subject, Need for environment studies, goals of environmental education, environmental education programs. Man-environment relationship, biogeochemical cycles. Concept of ecology, subdivisions and developmental phases of ecology; concept of the ecosystem, Structural and functional aspects of ecosystems; Productivity concept of ecosystem, food chains & food webs in ecosystems. Ecological energetic, ecological interactions. Population ecology, Population dynamics Soil, Land use patterns, Waste lands, Desertification, Water resources, Air resources, Energy resources, Waste management, Waste water management, Biomedical waste management, Environmental policies and laws
BMES121	Thermodynamics	3	0	3	Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of non reacting mixtures.
BMAO122	Probability & Statistics	3	0	3	Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectations; mean and variance; binomial; Poisson and distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distributions.
BMMATH123	Higher Calculus	3	0	3	Polar coordinates: Definition, graphing and conics , Cylindrical and spherical coordinates, Jacobian, Limits, Continuity and Differentiability of vector functions, Velocity & unit Tangent vector, Normal vectors, Curvature, Torsion and the Bi normal, Tangential & normal components of velocity and acceleration, Functions of several variables, Limits and continuity in higher dimensions, Partial derivatives, differentials,

Course Code	Course Title	L	P	U	Course Description
					linearization, Taylors formula for two variables, Chain rule for derivative, Directions derivatives, Gradient and Tangent planes, Maxima, Minima with application Convergence of sequences and series , Maclaurin, s Series, Taylors series, Vector calculus inRn, Vector analysis, Theorem of Green Gauss and Stokes
BMPHY124	Physics II	3	0	3	Electrical fied; magnetic field; electric current; electromagnetic induction; Max well's equation; Electromagnetic waves; wave particle duality; uncertainty principle and Bohr model of atom.
BMTA125	Scientific Measurements	0	4	2	A laboratory course that covers the lab components associated with six core science courses in the integrated first degree structure. While the exact component and assignments may vary from time to time. The assignments would invariably be illustrative of the theory covered in this portion as well as aim to emphasize the aspects of measurement as a theme in experimental science. This course is a compulsory requirement for all students who have to compulsorily do the six core science courses.
BMTA126	Workshop Practice	2	4	4	Basics of manufacturing processes, Technical and economical considerations of manufacturing, Significance of material properties with respect to selection of manufacturing processes, Fitting & Carpentry, Metal forming processes, Sheet-metal working, Mechanical joining processes, Smithy tools and making various parts, Casting processes, laboratory exercises involving machining, fitting & carpentry, joining, CNC, house wiring, foundry and smithy etc.
BMTA127	Computer Programming II	3	0	3	Java Programming Fundamentals, features of Object oriented programming, primitive data types and operators, various program control Statements, Classes, Objects and Methods, more data types and operators, Strings and other Operators, A closer look at methods and Classes, learn and implement Inheritance, Interfaces and Packages, Exception Handling, File I/O, Multithreading, database connectivity, Exploring My Cloud Powered by AWS : Essentials in Cloud Computing, Fundamentals of Big Data and Analytics, Introduction to Database Management System, Basics of Web Technologies, Basics of Storage and Networking, Cloud Computing Fundamentals and Services, AWS Analytics and Database Services, AWS Developer and Management Tools, AWS Storage Services, AWS Networking and Content Delivery Services.
BMES211	Electrical Sciences I	3	0	3	Introduction; basic circuit elements; sources (dependent and independent); Kirchoff's current and voltage law, source representation and conversion; Network theorems, response of RL,RC and RLC circuits; sinusoidal steady state analysis of circuits; three phase circuits, transformers; basics of rotating machines; DC machines; induction machine
BMES212	Digital Electronics	2	2	3	Number systems and machine representation, Boolean

Course Code	Course Title	L	P	U	Course Description
					algebra, minimization techniques, combinational and synchronous sequential circuits, logic minimization, programmable logic devices, state table and state diagrams, digital integrated circuits, asynchronous circuits, arithmetic operations and algorithms. The course will also consist of laboratory practice
BMES213	Engineering Mechanics	3	0	3	Introduction, System of Forces; Laws of Mechanics; Types of Supports and their reactions; Equilibrium of rigid bodies; Force resolution and Resultant force; Friction; Moments and couples; Varignon's Theorem; Center of Gravity; Moment of Inertia, product of inertia, Mass moment of inertia; Dynamics of particles- displacement, velocity and acceleration, D' Alembert's principle; Rectilinear motion; Impulse momentum principle; Impact of elastic bodies; Curvilinear motion; Work-energy principal.
BMECON214	Principles of Economics	3	0	3	Nature and Scope of economic science, its relationship with other social sciences; quantification of economic variables, theories of consumer behavior and of the firm; linear economic models; market structures; social accounting and basic elements of economic planning
BMMATH215	Complex Variables	3	0	3	Regions in the Complex plane, Functions of Complex Variable, limits. Mappings, Theorems on limits, Continuity, Derivatives, Cauchy-Riemann equations, Analytic Functions, harmonic functions, Exponential logarithmic functions, complex exponents, Trigonometric, Hyperbolic functions and their inverses, Contour integrals, Anti derivatives, Cauchy theorem, Cauchy Integral Formula, Morera's theorem, Liouville's Theorem, Maximum Modulus Principle, Convergence of sequences of series, Taylor's and Laurent series, Residues poles and zeros of analytic functions, Applications of residues, Conformal mapping, Fourier Transforms and Z Transforms.
BMMATH216	Differential Equations & Fourier Series	3	0	3	First order differential equations, Reduction of order, Second order equations with applications bending of beams and electrical circuits, The homogeneous equation with constant coefficients and the Method of Undetermined Coefficients, Variation of parameters, Higher order linear equations, Power series solutions and ordinary points, Frobenius Method &Regular singular points, Gauss' hyper-geometric equation, Legendre polynomials & Bessel functions, Laplace Transform & Inverse Laplace Transform, Convolution of Laplace Transform & application to differential equations, Fourier series and convergence, Cosine and Sine series, Sturm-Liouville problem, one dimensional Heat and Wave equations and Laplace equations in rectangular form.
BMES221	Electrical Sciences II	3	0	3	Semiconductor physics, doped semiconductors, junction diode, ideal diode, non-ideal diode models, Zener diode and their applications, effects of capacitance, PNP transistor, NPN transistor, cut off and saturation, application to digital logic circuits, Junction Field effect

Course Code	Course Title	L	P	U	Course Description
					transistors, MOSFETs, MOSFET Logic gates, Complementary MOSFETs, BJT Amplifiers, FET amplifiers biasing and small signal analysis ,Frequency response, power amplifiers, IC amplifiers, Operational amplifiers
BMTA222	Engineering Measurements	1	8	4	Measurement of basic electrical and non-electrical quantities; system performance measurements; analysis of experimental data. The course shall aim to train the student in the skill of operation of instruments in the electrical and electronics, chemical, civil and mechanical engineering applications. Precise lab exercises will be prescribed from time to time.
BMTA223	Professional Communication	3	0	3	Basics of Communication; Verbal and Non-verbal Communication; Barriers to Communication; Business Correspondence; E-mail Communication; Memo-Reports; Notice, Agenda and Minutes of Meetings; Effective Writing; Report: Its Features: Types of Reports; Formal Reports; Gathering Information; Organization of the Material; Uses of Visual Aids; Writing Abstract and Summaries; Writing Definitions; Reading and Listening Skills; Note-making; Précis Writing; Audio Visual Aids; Oral Presentation; Editing; Mechanics of Writing.
BMMGTS 224	Principles of Management	3	0	3	Fundamental concepts of management-planning-organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.
BMAO225	Optimization Techniques	3	0	3	Optimization of functions of one and more variables with and without constraints, Kuhn-Tucker conditions, Gradient Methods, Linear Programming, Simplex based and integer programming methods, Duality Theory, Transportation and assignment problems, Dynamic programming, Branch and bound methods, Models of linear production systems
BMAO311	Numerical Methods	3	0	3	Solution of non-linear algebraic equations; interpolation and approximation; numerical differentiation and quadrature; solution of ordinary differential equations; system of linear equations; matrix inversion; Eigen-value and Eigenvector problems.
BMAO312	Control Systems	3	0	3	Mathematical models of physical systems, feedback characteristics of control systems, control system components, time response analysis, stability, frequency response, state-space analysis
BMHS311	Dynamics of Social Change	3	0	3	Nature of Society, social institutions; concept and nature of socio-cultural change, obstacles, rate and direction of change; factors of social change ideological, economic, technological and political demographics; agencies of

Course Code	Course Title	L	P	U	Course Description
					social change-education, leadership, propaganda, legislative reforms; five-year plans and social change, peasant and land reform, bhoodan and gramdan; changing pattern of family, marriage, caste and religion
BMHS312	Introduction to Psychology	3	0	3	The development of psychology as a science individual and the environment; nature; kinds and determinants of perceptions; response mechanism and kinds of responses, motivations, modifications of behaviour through learning, memory and transfer of training; thought process, problem solving and creative thinking; nature and evaluation techniques of intelligence and personality.
BMHS313	Heritage of India	3	0	3	Foundations of India; India and its ancient culture; life of the people; systems of Indian philosophy; art and archeology; languages and literature; impact of world civilization; Western influence.
BMHS314	Modern Political Science	3	0	3	Nature and scope of political science; emergence and basis of the state; rights and duties; forms of government; democracy, fascism, capitalism, socialism, anarchism, communism, Maoism, radicalism and Gandhism.
BMHS315	Public Administration	3	0	3	Definition, nature and scope of public administration; the chief executive; leadership qualities of an administrator; principles of organization; organization of Ministries of Home and Finance; personnel administration-bureaucracy; recruitment, promotion, conduct and discipline, employer employee relations; administration at work-planning, policy formulation, decision making, supervision, coordination; integrity in administration; public corporations in India; financial administration in India; local administration in India.
BMHS316	Professional Ethics	3	0	3	Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.
BMDS491 BMCE491 BMCS491 BMEC491 BMEE491 BMME491 BMMEC491	Special Projects	0	0	3	This is an unstructured open ended where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time bound which is of basic or peripheral concern of student's discipline. Each student must submit a project report as a culmination of his endeavor and investigation. The instructor-in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. This course will aim to evaluate the student actual ability to use the fundamentals of knowledge and to meet the new unknown situations as demonstrated by the student's interaction with the instructors and instructor-in-charge. The instructor-in-charge may assign specific hours of formal brain storming sessions.

B.Sc. Program (Mathematics)

Course Description

Course Code	Course Title	L	P	U	Course Description
MATH221	Stochastic Processes	3	0	3	Introduction of Stochastic process, specification of stochastic process, Stationary process, martingales. Markov chain, Transition probability, Classification of states and chains, Determination of higher transition probability, Stability of Markov chain, Reducible chains, Markov chain with discrete and continuous space.
MATH222	Partial Differential Equations & Systems of ODEs	3	0	3	Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients(Two Equations in two unknown functions). Simultaneous linear first order equations in three variables, methods of solution, Pfaffian differential equations, methods of solutions of Pfaffian differential equations in three variables. Formation of first order partial differential equations, Linear and non-linear partial differential equations of first order, special types of first-order equations, Solutions of partial differential equations of first order satisfying given conditions. Linear partial differential equations with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients, Partial differential equations with variable coefficients, Separation of variables, Non-linear equation of the second order.
MATH311	Real Analysis	3	0	3	Review of Algebraic and Order Properties of R, Neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima. The Completeness Property of R, The Archimedean Property, Density of Rational and Irrational numbers in R, Intervals. Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotonic Sequences, Monotonic Convergence theorem (weierstrass completeness theorem). Cantor's completeness theorem. Subsequences, Divergence Criteria, Monotonic Sub-sequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criteria. Infinite series, convergence and divergence of infinite series, Cauchy Criteria, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n-th root test, Integral test, Alternating series, Leibnitz test, Absolute and Conditional convergence.

Course Code	Course Title	L	P	U	Course Description
MATH312	Algebra	3	0	3	Binary algebras, Cyclic monoids, submonoids, Groups, Morphisms, direct products, Examples of Groups, postulates, subgroups, Abelian groups, Groups acting on sets, Permutations, Lagrange's theorem, Normal subgroups. (Rings and Ideals) Introduction, Integral domains and fields, Fields of quotients, Subrings, Morphism of rings, Direct sums, ideal and quotient rings, Divisibility, Euclidean domains, Unique factorization theorem, Prime and maximal ideals, Gaussian elimination. (Polynomial Rings and polynomial codes :) The Rings R[x], polynomial rings over fields, Polynomial codes, Advantageous properties, Shift registers, Unique factorization theorem for polynomials, Complete roots of unity, polynomial functions, Formal derivative. (Finite Fields :) Extension of fields, simple extensions, Computation in R[x]/m[x], Existence theorem, Finite fields. Lattices: Lattices and Posets,
MATH313	Graph Theory	3	0	3	Graphs: Basic concepts and graph terminology, representing graphs and graph isomorphism. Distance in a graph, Cut-vertices and Cut-edges, Connectivity, Euler and Hamiltonian paths.
MATH314	Combinatorial Mathematics	3	0	3	Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers Principle of Inclusion and Exclusion, Derangements, Inversion formulae Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions. Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions. Integer partitions, Systems of distinct representatives.
MATH315	Cryptography	3	0	3	Elementary number theory: Prime numbers, Fermat's and Euler's theorems, Testing for primality, Chinese remainder theorem, discrete logarithms. Finite fields: Review of groups, rings and fields; Modular Arithmetic, Euclidean Algorithms, Finite fields of the form GF(p), Polynomial Arithmetic, Finite fields of the form GF(2). Data Encryption Techniques: Algorithms for block and stream ciphers, private key encryption – DES, AES, RC4; Algorithms for public key encryption – RSA, DH Key exchange, KERBEROS, elliptic curve cryptosystems. Message authentication and hash functions, Digital Signatures and authentication protocols, Public key infrastructure, Cryptanalysis of block and stream ciphers.
MATH316	Statistical Methods	3	2	4	Random variables: probability distributions; Sampling distributions; Test of hypotheses; test for goodness of fit; analysis of variance; non-parametric tests; correlation and

Course Code	Course Title	L	P	U	Course Description
					regression analysis.
MATH317	Differential Geometry	3	0	3	Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves. Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves. Developables: Developable associated with space curves and curveson surfaces, Minimal surfaces. Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Eulers theorem. Rodrigues formula, Conjugate and Asymptotic lines.
MATH323	Metric Spaces	3	0	3	Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantors theorem. Subspaces, dense sets, separable spaces. Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem. Connectedness, connected subsets of R.
MATH324	Rings and Fields	3	0	3	Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x]. Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains. Algebraic extension of fields: Irreducible polynomials and Einstein criterion, Adjunction of roots, Algebraic extension. Algebraically closed fields, Normal separable extensions: splitting fields, normal extensions. Normal separable extension: Multiple roots, Finite fields, Separable extensions. Galois Theory: Automorphism groups and fixed field s, Fundamental theorem of Galois theory. Application of Galois theory to classical problems: Roots of unity and Cyclotomic polynomials, Cyclic extensions.
MATH325	Topology	3	0	3	Countable and uncountable set, Infinite sets and the Axiom of choice, Well-ordered sets. Topological spaces, Basis and sub basis for a topology, The order, product and subspace topology, closed sets and limit points. Continues function and homeomorphism, Metric topology, Connected spaces, connected subspaces of the real line, Components and local connectedness. Compact spaces, Basic properties of compactness, Compactness and finite intersection property, Compact subspaces of the real line, Compactness in metric spaces, Limit point compactness, Sequential compactness and their equivalence in metric spaces, Local compactness and one point

Course Code	Course Title	L	P	U	Course Description
					compactification. First and second countable spaces, Lindel of space, Separable spaces, separable axioms, Hausdorff, Regular and normal spaces. The Urysohn lemma, completely regular spaces, The Urysohnmetrization theorem, Imbedding theorem, Tietn extension Theorem, Tychonoff theorem, Stone-Cechcampactification.
MATH326	Advanced Probability Theory	3	0	3	Measures: Classes of sets, Caratheodory extension of measures, Lebesgue-Stieltjes measures on R^2, Lebesgue-Stieltjes measures on R^2, Completeness of measures, Measurable transformations, Induced measures, distribution functions, Generalizations to higher dimensions, Integrals, Riemann and Lebesgue integrals, More on convergence, The Lebesgue-Radon-Nikodym theorem, Functions of bounded variation, Absolutely continuous functions on R, Singular distributions, Decomposition of a cdf, Product spaces and product measures, Fubini-Tonelli theorems, Probability Spaces, Kolmogorov's probability model, Random variables and random vectors, Kolmogorov's consistency theorem, Independence, Independent events and random variables, Borel-Cantelli lemmas, tail σ-algebras, and Kolmogorov's zero-one law, Laws of Large Numbers: Weak laws of large numbers, Strong laws of large numbers, Series of independent random variables.
MATH327	Continuum Mechanics	3	0	3	Vector spaces, index notation, second order tensors: skew symmetric, orthogonal and symmetric tensors, invariants of second-order, directional derivative, Frechet derivative, gradient, divergence, curl, and integral theorems. Lagrangian and Eulerian description, deformation gradient, strain tensor, stretchtensors, area and volume transformation, material and spatial derivative, rate of deformation and spin tensors, Reynolds' transport theorem, vorticity and circulation. Connservation of mass, conservation of linear momentum, the Cauchy's hypothesis, Cauchy stress tensor, conservation of angular momentum, first law of thermodynamics, second law of thermodynamics, governing equations in reference configuration and also for control volume, principle of frame-indifference. necessity of constitutive relations, principle of material frame - indifference, material symmetry, thermoelastic solids, hyperelasticity, linear elasticity, thermomechanics of fluids, classical heat-conducting fluids, incompressible fluids.

4. Institute Core Courses Handouts

Course No: **BMCHEM111**	Course Title: **Chemistry**	L	P	U
		3	0	3

Course Learning Objectives

- To integrate the principles of Inorganic, Physical and Industrial chemistry with the relevant domains of core engineering courses offered at B.Tech level.
- To provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.
- Provides a comprehensive survey of underlying principles that govern the properties and behavior of chemical systems.
- The student will understand the interdisciplinary nature of chemistry and to integrate knowledge of mathematics, physics and other disciplines to a wide variety of chemical problems.

Course Contents

UNIT-I

Werner's work, recent studies on complexes, Effective atomic number, Nomenclature of coordination compounds, Shapes of d-orbitals, Valence Bond Theory, Crystal Field Theory of Octahedral Complexes, Magnetism, Thermodynamic aspects of crystal field splitting, Tetragonal distortions of Octahedral Complexes (Jahn-Teller Distortions), Square Planar and Tetrahedral Complexes.

UNIT-II

Work and Heat, Internal Energy and Enthalpy, Enthalpy changes accompanying physical change and chemical change, Entropy and 2nd Law, Absolute Entropies and 3rd Law, The Gibb's Energy, The thermodynamics of transition, Phase diagrams, and Phase diagrams of typical materials, The reaction Gibb's energy, Variation of reaction Gibbs energy with composition, Reactions at equilibrium, The standard reaction Gibbs energy, Equilibrium composition, Equilibrium constant in terms of concentration, The response of equilibria to the conditions, Proton transfer equilibria, Salts in water, Solubility equilibria.

UNIT-III

The migration of ions, Half reactions and electrodes, Reactions at electrodes, varieties of cells, The cell reactions, Cell potential, Cells at equilibrium, standard potentials, The variation of potential with pH, Determination of pH, Electrochemical series, Determination of thermodynamic functions.

UNIT-IV

Empirical chemical kinetics, Reaction rates, Temperature dependence of reaction rates, Reaction schemes and reaction mechanisms.

UNIT-V

Basic industrial processes like distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, Emulgator, Scaling up operations in chemical industry, Introduction to clean technology, Introduction to synthesis, properties and application of nano-materials

Text Books:

1. Lee J. D., "*Concise Inorganic Chemistry*", 5th Edition, Blackwell Science, Oxford University Press, New Delhi, 1996.
2. Atkins Peter and De Paula Julio, "*The Elements of Physical Chemistry*", 6th Edition, Oxford University Press, New Delhi, 2015.
3. Felder R.M., Rousseau R.W. "*Elementary Principles of Chemical Processes*", Wiley Publishers, New Delhi, 2006.
4. Dieter Vollath, "*An introduction to synthesis, properties and application of nano-materials*", 2nd Edition, Willey, New York, 2013.

Reference Books:

1. Levine Ira N., "*Physical Chemistry*", 5th Edition, Tata McGraw-Hill, 2002.

2. Mahan Bruce M. and Mayers Rollie J., "*University Chemistry*", 4th Edition, Addison, Wesley Longman, 1998.

3. Huheey James E, Keiter Ellen A and Keiter Richard L., "*Inorganic Chemistry*", 4th Edition, Harper Collins College Publishers, 1993.

4. Stocchi E, "*Industrial Chemistry*" Vol-I, Ellis Horwood Ltd. UK.2006.

Course Outcomes

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

- Understand the chemical behaviour of matter and materials using fundamental knowledge of their nature (i.e. electrons and intermolecular forces)
- Correlate the concepts of thermodynamics learnt with the study of engineering devices covered in Mechanical Engineering.
- Use fundamental chemical principles to make predictions about reactivity and general properties of materials of the built environment.
- Predict potential complications from combining various chemicals or metals in an engineering setting.
- Apply concepts learnt to the basic requirements of Civil Engineering, particularly focusing to the built environment
- Collect, represent and interpret experimental results accurately and concisely using technical narrative, graphs, and tables.

Skill Development/Employbility/Entreprenunership

- List of Experiments in Chemistry

Sl. No	Name of the Experiment
1.	Estimation of iron (Fe+2) by Dichrometry
2.	Estimation of copper by Iodometry
3.	pH curve of an acid base titration using Potentiometer
4.	Dissociation constant of a weak electrolyte by conductometry
5.	Colorimetric estimation of Iron
6.	Estimation of strength of oxalic acid using potassium permanganate as an intermediate solution
7.	Kinetics of iodination of acetone
8.	Synthesis of trans-dichlorobis (ethylenediamine) Cobalt (III) chloride
9.	Synthesis of Nickel(II)-Dimethylglyoxime complex
10.	Determination of rate constant and activation energy of the given ester catalysed by an acid
11.	Estimation of Copper by Complexometry

Course No: **BMELS112**	Course Title: **English Language Skills**	L	P	U
		2	4	4

Course Learning Objectives

- Tofamiliarizing learners with aspects of pronunciation to attain intelligibility and grammatical accuracy in spoken and written English.
- To provides intensive practice and extensive exposure to the four basic skills; listening, speaking, reading and writing

Course Contents

UNIT-I

English Sound System: distinction between letters and sounds, classification of English sounds, syllable structure, confusing sounds for practice, words and sentences for practicing vowel contrasts.

Accent Patterns: accentual patterns of single words, accentual patterns of compound words, accent change according to function, sentence accent.

Effective speech: elision of sounds or syllables, addition of sounds or syllables, transposition sounds, pronunciation based on semantics, inflectional suffixes and some common word endings, general suggestions for pronunciation, Pronunciation of consecutive consonants.

Listening skills: hearing and listening, phonetic features of listening, purpose of listening, barrier to listening, guidelines for improving listening.

Art of conversation: small talk, body language, principles of a good conversationalist.

Debate: process of organization, purpose, rebuttal, participating in a debate, preparation for the debate.

Group Discussion: conversation, debate and GD, kinds of groups, importance and features of GD (oral communication skill, leadership skills, intensive listening skills, nonverbal communication clues), strategies of a group interaction, barriers to an effective GD, suggestions for self-improvement.

UNIT-II

Uses of dictionary: the meaning, spelling and pronunciation of a word, antonyms and synonyms, grammar, abbreviations and dictionary symbols, use of thesaurus.

Punctuation: end punctuation marks, internal punctuation marks, direct quotation punctuation marks, word punctuation, spacing with punctuation, too much punctuation.

Prepositions and phrasal verbs: prepositions and phrasal verbs prepositions, Idiomatic combinations, phrasal verbs, Vocabulary extension: context clues, word analysis, semantic change, word-formation methods, antonyms, synonyms, one word substitutions.

Effective use of words: word order, words: its meaning, avoid clichés

Common errors in English: errors in using nouns, errors in using pronouns, errors in using prepositions, errors in using verbs, errors in using gerund/infinitive, use an infinitive not a gerund, errors in using adjectives, errors in using adverbs, errors in using conjunction, errors in using punctuation, common errors due to commonly confused words

UNIT-III

Effective use of sentences: unity and emphasis on sentences, coordination and subordination. Paragraph writing: unity, coherence and development of the paragraph, types of paragraphs, paragraph development.

Essay writing: features of an essay, thesis statement, organization of the material, modes of developing essays, Revise and proofread essay, practice essay.

UNIT-IV

Reading Skill: mechanics of reading, types of reading, reading speed.

UNIT- V

Business correspondence: structure and layout of business letters, enquiry letter and important points, complaint and adjustment letters, complaint letter, important points, sales letter.

Resume writing: elements of resume, preparing a resume, writing a job application letter Presentation Skills: Tips for making presentations.

Text Books:

1. Koneru. A. (2011). English Language Skills. McGraw Hill

Reference Books:

1. Langan, J. (2010). College writing skills. McGraw-Hill, Eighth Edition.
2. Langan, J., & Jenkins, L. (2010). Ten steps to advancing college reading skills. Townsend Press.
3. Swan, M. (2016). Practical English Usage 4th edition.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Develop listening skills to distinguish between letters and sound to use them effectively in speech during standard communication or debates and group discussions.
- Use dictionary and grammar effectively to overcome errors in reading and writing.
- Frame sentences and effectively use while writing paragraphs, essays, business letters and resumes etc.

Skill Development / Employability / Entrepreneurship

English communication Skills Lab

Cycle 1	Cycle 2
Why study spoken English	Debates
Phrases and Conversations	Group discussion
Letters and sounds	Presentation skills
Phonetics	Interview skills
Lab Exercises	e-Correspondence
Word accent and Stress shifts	Resume Writing
Telephone skills	Idioms
Intonation Body Language	Common errors in English
Grammar	
Vocabulary	

Course No: **BMMATH113**	Course Title: **Linear Algebra**	L	P	U
		3	0	3

Course Learning Objectives

- To solve systems of linear equations
- To compute standard forms of given matrices
- To compute eigenvalues and eigenvectors of 3x3 real matrices
- To compute quadratic forms and diagonalize matrices.
- To introduce complex matrices and obtain analogues of real matrix theorems

Course Contents

UNIT-I Matrices, Matrix addition, Vectors and Scalar Multiplication, Matrix Multiplication, Rank of a matrix Symmetric, Skew-symmetric matrices Row Operation, Row Equivalence, Row Reduced Echelon Matrices

UNIT-II Linear systems of Equations, Gauss Elimination, Determinant method: Cramer's Rule Solutions of Linear systems, Existence and Uniqueness, Inverse, Gauss-Jordan Method

UNIT-III The matrix eigenvalue problem, Determining eigenvalues and eigenvectors, applications

UNIT-IV Vector spaces, Linear Independence, Inner product spaces, subspaces Linear Transformations, Algebra of linear Transformations, Isomorphism between Matrices and Linear Transformations

UNIT- V Similarity of Matrices, Diagonalization, Quadratic Forms, Canonical forms Complex Matrices and Forms Hermitian, Skew-Hermitian, Unitary matrices and Orthogonal matrices

Text Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig ,10th Edition, John Wiley & Sons, 2012.

2. An Introduction to Linear Algebra, V. Krishnamurthy, V. P. Mainra, J. L. Arora, East West Press,2002

Reference Books:

1. Linear Algebra and its Applications, Gilbert Strang,
2. 4th Edition, Thomson Brooks, 2006

Course Outcomes

Upon successful completion of the course, student will be able to:

- Systematically solve sets of linear equations of small size
- Analyse eigenvalue/eigenvector problems and compute the same
- Apply the concept of rank for a variety of problems
- Perform diagonalization and related operations on quadratic forms

Skill development/Entrepreneurship/Employability:
Knowledge in singular value decomposition which leads to Matrix Software Development. Ample scope in Machine Learning, and Artificial Intelligence.

Course No: **BMPHY114**	Course Title: **Physics-I**	L	P	U
		3	0	3

Course Learning Objectives

Develop an understanding of the basic principles of Mechanics and wave optics and the application of the principles with emphasis on problem solving skills.

Course Content:

UNIT I

Conservation of Momentum: Collisions, Impulse-Momentum Theorem, Conservation of Momentum, Two-body collisions, Complex Motions, Many-particle systems, Center of Mass and Conservation of momentum

UNIT II

Rotational motion: Rotational Kinematics, Relation between linear and angular variables, Torque and Rotational inertia, rolling without slipping, Angular momentum for system of particles, Conservation of angular momentum

UNIT III

Conservation of Energy: Work, Energy and Power, Work-Energy theorem, Conservative forces, Potential energy, Conservation of mech. Energy, Work done by ext. force, Frictional force, Conservation of total energy

UNIT IV

Oscillators and Waves: Simple Harmonic Oscillator, Free, Damped and Forced Oscillations, Types of waves, Traveling waves, Interference of waves, Standing waves etc

UNIT V

Optics: Double-Slit interference, Interference due to thin films, Single Slit diffraction Intensity calculation, Multiple slits, Diffraction gratings, Dispersion and Resolving power

Text Books:

1. Robert Resnick, David Halliday and Kenneth S. Krane "Physics", Vol. I and II, 5th Edition John Wiley Inc, Singapore, 2002.

Reference Books:

1. Robert Resnick, David Halliday and Jearl Walker "*Fundamentals of Physics*", 6th Edition, John Wiley Inc, Singapore, 2001.
2. Cutnell and Johnson, "*Physics*", 5th Edition, John Wiley, Asia, 2001.

Course Outcomes

- Apply conservation of linear momentum to two/many body systems in lab and centre of mass frame of reference.
- Apply conservation of angular momentum to two/many body systems in lab and centre of mass frame of reference.
- Apply the conservation of energy principle and find the work done by a body under the influence of conservative/non-conservative forces.
- Understand the types of oscillations/waves and the fundamental equations governing them.
- Understand the physics of the most important phenomena in wave optics, namely, interference, diffraction.

- **Skill Development / Employability / Entrepreneurship**
- **Physics lab:**
-

S.NO	NAME OF THE EXPERIMENT
1	Graph Drawing
2	Vernier callipers and Screw gauge
3	Error analysis and Graph drawing
4	Compound Pendulum
5	Dispersive power of the material of a prism
6	Flywheel
7	Parallelogram law of forces and Lami's Theorem
8	I-V Characteristics of a Solar Cell
9	Measurement of e/m by Thomson's Bar magnet method
10	Determining Planck's constant
11	Hall effect
12	Diffraction Grating
13	Magnetic field along the axis of current carrying coil by Stewart and Gee's method
14	Mapping of magnetic lines of force around a bar magnet
15	Resonance in LCR circuits

Course No: **BMTA115**	Course Title: **Engineering Graphics**	L	P	U
		2	4	4

Course Learning Objectives

- To enhance the visualization and imagination abilities
- To promote creative thinking for solving engineering problems.
- To take data and transform it into drawings.
- To learn basic Auto CAD skills
- To learn basic Engineering formats

Course Contents

UNIT-I

Drawing conventions & Practices, Dimensioning, Geometrical terms, bisecting a line, angle, arc. Regular polygons, curves.

Introduction to CAD, limits, toolbars, starting new drawing, saving new drawing, etc. Simple commands like line, circle, polygon, etc and formatting commands, 2D exercises

UNIT-II

First and third angle projections, Multi view drawing from pictorial views. Projections of points, Projection of lines, true lengths, true inclinations, shortest distances between lines.

UNIT-III

Projections of planes, Primary and Secondary auxiliary views, true shapes. Projections of solids inclined to both the planes.

UNIT-IV

Construction of Sectional views of truncated solids, Development of surfaces - Parallel Line method, Radial Line Method, Intersection of surfaces

UNIT- V

Construction of isometric views from orthographic projections, Missing Views- identifying missing Views.

Text Books

1. Engineering Drawing with an Introduction to AutoCAD, D.A.Jolhe, TMH, 5th edition, 2010
2. Fundamentals of Engineering Drawing, Warren J. Luzzader & Duff J. M., PHI, 11th edition., 2015

Reference Books

1. Engineering Drawing, K.Venugopal, New Age International (P)., 2006
2. Engineering Drawing, N.D.Bhatt, V.M.Panchal , Charotar Publishing, 53rd edition, 2014
3. Engineering Graphics with Auto CAD 2002", James D. Bethune, PHI, 2002

Course Outcomes

Upon successful completion of the course, student will be able to:

- To specify units, limits of drawing. It also includes creating and editing 2 D computer geometry, and constructing lines, arcs, chamfers and fillets.
- Draw parallel and perpendicular lines, and to construct circles, arcs, tangencies and curves.
- Apply standard vertical, horizontal, radius, diameter, and other dimensions to an engineering drawing.
- Generate Engineering Drawings using drafting tools
- Visualize geometrical solids in 3D space through exercises in Orthographic Projections
- Draw auxiliary views and isometric views
- Develop the surfaces of geometrical solids
- **Skill Development / Employability / Entrepreneurship**
-

Name of the Laboratory: Engineering Graphics	
Sl. No.	**List of Topics for practice**
1	Methods of dimensioning
2	Geometric constructions
3	Construction of engineering curves, conics and scales
4	Orthographic Projections

5	Projections of Points and Lines
6	Auxiliary Views
7	Shortest Distance between graphical elements
8	Obtaining true shape of planes
9	Projections of Planes and Solids
10	Sections of solids
11	Development of Surfaces
12	Intersection of Surfaces
13	Isometric Views
14	Perspective projections

Course No: **BMTA116**	Course Title: **Computer Programming I**	L	P	U
		3	0	3

Course Learning Objectives

- To introduce the basic concepts of UNIX operating systems.
- To understand the fundamentals of Problem Solving.
- To learn how to design and program Python applications.
- To learn how to design object-oriented programs with Python classes.
- To learn how to use exception handling in Python applications for error handling.

Course Contents

UNIT-I

Introduction to UNIX: Multi-programming, Time sharing, personal computer, and UNIX operating system, etc. **General Purpose Utilities & File System:** cal, date, and echo, etc directory related commands: pwd, cd, mkdir, rmdir, file related commands.**Simple and Advanced Filters:** head, tail, paste, sort, uniq, grep and sed, etc, **Basics of Problem solving: Building** blocks of algorithms (statements, state, control flow, functions), notation.

UNIT-II

Algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion), Example: find minimum in a list, insert a card in a list of sorted cards, and Towers of Hanoi etc. **Introduction to python:** History of Python, Need of Python Programming, Applications Basics of Python Programming, Data Types: Declaring and using Numeric data types.

UNIT-III

Data Types string data type and string operations, fining list and list slicing, Tuple, string, list and dictionaries **Python Program Flow Control:** if, else and else if, for loop, while loops continue, and break **Python Sequences:** String in build methods, List and dictionary manipulation, Programming using string, list and dictionary

UNIT-IV

Python Functions: Organizing python codes using functions **Python Modules:** Organizing python projects into modules, importing own module as well as external modules **Python Packages:** Lambda function, Programming using functions, modules and external packages

UNIT-V

Python Object Oriented Programming: Class, object and instances Constructor, class attributes and destructors, Real time use of class in live projects Inheritance, overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, **Exception Handling:** Avoiding code break using exception handling, Safe guarding file operation is using exception handling, Handling and helping developer with error code.**AWS Educate:** Introduction to Cloud Computing, Overview of Cloud Models, Cloud Inventor Certification.

Text Books:

1. Learning Python, Mark Lutz, Orielly, 5 Edition, 2013.

Reference Books:

1. How to Think Like a Computer Scientist: Learning with Python 3, Peter Wentworth, Jeffrey Elkner, Allen B. Downey and Chris Meyers, 3rd Edition, 2019.
2. Fundamentals of Python: First Programs, Kenneth A. Lambert, Cengage, 1st Edition, 2011.
3. Charles Dierbach, —Introduction to Computer Science using Python: A Computational Problem- Solving Focus, Wiley India Edition, 2013.
4. UNIX Concepts and Applications, Sumitabha Das, TMH, 4th edition, 2006.

Course Outcomes

After successful completion of the course student will be able to

- To execute shell commands in Linux.
- Understand, analyze and solve problems using algorithmic approach.
- Write Python programs using conditional statements, loops and functions.
- Use Python data structures -- lists, tuples, dictionaries.
- Do input/output with files in Python.
- Understand the Importance of cloud computing and its applications.

Skill Development / Employability / Entrepreneurship

COMPUTER PROGRAMMING – I

LIST OF EXPERIMENTS

1. Programs to implement basic I/O operations.
2. Programs to implement conditional statements (if, if-else etc...).
3. Programs to implement loops (while, do while and for).
4. Programs to implement single and multidimensional array.
5. Programs to implement different types of functions.
6. Programs to implement basics of pointers.
7. Programs to implement structures and unions.
8. Programs to implement various string handling functions.
9. Programs to implement file I/O.
10. Programs to implement dynamic memory allocation functions.

Course No: **BMEVS117**	Course Title: **Environmental Science**	L	P	U
		2	0	2

Course Learning Objectives

- To understand the fundamentals of environment
- To understand the science of interrelationship between the living organisms and their environment
- To understand the relationship between the population and the environment.
- To have an understanding about the land resources, water resources, air recourses and their pollution, control methods
- To have an understanding about the waste management.
- To know about the environmental policies and laws.

Course Contents

UNIT-I

Meaning of Environment, Types and components of environment, nature and scope of the subject, Need for environment studies, goals of environmental education, environmental education programs, Man-environment relationship, biogeochemical cycles.

UNIT-II

Concept of ecology, Subdivisions and developmental phases of ecology, Concept of the ecosystem, Structural and functional aspects of ecosystem, Productivity concept of ecosystem, food chains and food webs in ecosystems, Ecological energitics, ecological interactions, Population ecology, Population characteristics, Population dynamics, population regulation.

UNIT-III

Nature and importance of soil, Formation of soil, soil properties, Nutrients in soil soil erosion, contamination of soil, Land use, Waste lands, Desertification.Introduction, properties of water, hydrological cycle, Water resources, waste water of India-its future, Water pollution, Pollution of ground water.

UNIT-IV

Origin of the atmosphere, composition of the air, structure of the atmosphere, Air pollution, Effects of air pollution on human health, flora and fauna, Global effects of air pollution.

UNIT-V

Energy, sources of energy, conventional and non conventional sources of energy, Waste water management, biomedical waste management, Air pollution control, Environmental policies and laws.

Text Books:

(1) A Text Book of Environment, Agarwal, K.M., Sikdar, P.K and Deb.S.C Mac Millan India Ltd., 2002.

Reference Books:

(1) A Text Book on Environmental Science, V. Subramanian, Third reprint, Narosa Publishing House, 2005.

(2) Environment, Raven, Peter H., and Linda R. Berg. 3rd ed., Fort Worth: Harcourt College Publishers, 2001.

Course Outcomes

After successful completion of the course student will be able to

- Understand the natural environment and its relationships with human activities.
- Characterize and analyze human impacts on the environment.
- Integrate facts, concepts, and methods from multiple disciplines and apply to environmental issues.
- Acquire practical skills; devise methodologies for scientific problem-solving, including familiarity with laboratory and field instrumentation.
- Understand and implement scientific research strategies, including collection, management, evaluation and interpretation of environmental data.
- Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Skill development / employability / entrepreneurship

List of experiments in environmental science

sl. No	Name of the experiment
1	To determine total hardness of water sample by edta method
2	Determination of oxygen dissolved in water by winkler's method
3	Estimation of chloride content in water by argentometric method [mohr's method]
4	Estimation of carbonates and bicarbonates in water sample
5	Determination of hexavalent chromium in water samples by colorimetric method
6	Determination of acid value of lubricating oil
7	Determination of percentage of copper in brass
8	Determination of viscosity of lubricating oil by redwood viscometer

Course No: **BMES121**	Course Title: **Thermodynamics**	L	P	U
		3	0	3

Course Learning Objectives

- To study the properties of pure substances and their use in widely used devices such as steam power plant, fuel cells, refrigerator, Turbine and Pumps.
- To know how to use the thermodynamic tables to identify the phase of a given state of matter and estimate the quality of saturated liquid vapor mixture
- To understand the concept of heat and work and estimate the same at the boundary of real time systems
- To know the application of first law for closed systems and the interpretation of thermodynamic properties such as Internal Energy and Enthalpy and determine their change during a process; To know the application of first law for control volume systems and to understand the transient process
- To know the application of second law of thermodynamics and to know the thermodynamic temperature scale; To understand the concept of entropy and entropy change in solid, liquid and liquids and gases
- To delimit the application of second law for control volume systems and to understand the concept of efficiency of engines

Course Contents

UNIT-I

Introduction to some devices like steam power plant, fuel cells etc.; Thermodynamic system, properties and state, processes and cycles, force, energy, pressure, specific volume, Zeroth law and numerical problems; Phase equilibrium, independent property, compressibility factor; Study of steam tables and solving numerical problems.

UNIT-II

The concept of heat and work: Definition of work, understanding of piston work; Understanding of heat concept, modes of heat transfer and numerical problems on it; Definition of first law, first law for a change of state, internal energy and enthalpy; Specific heat, internal energy and enthalpy of an ideal gas, first law as a rate equation and numerical problems

UNIT-III

Application of first law for control volume systems: Conservation of mass in control volume, first law for a control volume, SSSF process and examples on it viz. Heat exchangers, Nozzles and diffusers, Throttle, Compressor & Pump, Steam Power Plant and Refrigerator; Transient process: Study of USUF process, numerical problems on it

UNIT-IV

Application of second law of thermodynamics: Heat engines and refrigerators, the Clausius and the Kelvin plank statement, reversible and irreversible processes, study of Carnot cycle and efficiency of a cycle; Thermodynamic and ideal gas temperature scale, numerical problems on it

UNIT-V

The concept of entropy: Clausius inequality, study of entropy as a property, thermodynamic property relations, entropy change of reversible and irreversible processes, entropy generation and principle of increase of entropy; Entropy change in solid, liquid and gases, polytropic process, entropy as rate equation, numerical problems; Second law for control volume, study of entropy for both reversible and irreversible processes, principle of increase of entropy; Understanding efficiency and related numerical problems

Text Books:

1. Fundamentals of Thermodynamics ISV, Sonntag R E & Claus B John Wiley, 7th Edition, 2009.

Reference Books:

1. Thermodynamics, P.K.Nag, Tata Mc Graw Hill Publishing Company limited, New Delhi, 3rd Edition, 2004.
2. Fundamentals of Engineering Thermodynamics, Michael J Moran and Howard N Shapiro, John Wiley, 5th Edition, 2004.
3. Thermodynamics- An Engineering Approach, Yunus A. Cengel and Michael A Boles, Tata Mc Graw Hill Publishing Company limited, New Delhi, 5th Edition, 2006.

Course Outcomes

Upon successful completion of the course, student will be able to:

- *Identify* and explain the basic concepts of thermodynamics like system, properties and their quantification
- *Calculate* thermodynamic properties using steam tables and *analyze* the processes on T-v diagrams to solve advanced engineering problems
- *Explain* the concept of thermodynamic work. *Calculate* and *compare* work for systems executing different thermodynamic processes or different thermodynamic cycles
- *State* and *apply* the first law of thermodynamics for closed and open systems undergoing different thermodynamic processes. *Evaluate* the performance of steam power plants, refrigeration plants and their components
- *Evaluate* the feasibility of a thermodynamic cycle using the second law of thermodynamics for typical engineering problems
- *Quantify* the second law of thermodynamics for a cycle by establishing the inequality of Clausius. *Apply* the inequality of Clausius and *establish* the property, entropy of a system. *Apply* principle of increase of entropy to *evaluate* the feasibility of a thermodynamic process

Course No: **BMAO122**	Course Title: **Probability & Statistics**	L	P	U
		3	0	3

Course Learning Objectives

- This course introduces the concept of probability and enables the student to become familiar with probabilistic concepts,
- A selected study of discrete & continuous distributions and their characteristics

Course Contents:

UNIT-I

Sample Spaces and Events, Counting, Probability, The Axioms of Probability, Some elementary Theorems, Conditional Probability, Bayes' Theorem

UNIT-II

Random Variables, The Binomial Distribution, The Hypergeometric Distribution, The Mean and the Variance of a Probability Distribution, Chebyshev's Theorem, The Poisson Distribution, Poisson Processes, The Geometric and Negative Binomial Distribution, The Multinomial Distribution.

UNIT-III

Continuous Random Variables, Normal Distribution, Normal Approximation to the Binomial Distribution, Other Probability Densities, the Uniform Distribution, Log-Normal Distribution, Gamma Distribution, Beta Distribution, TheWeibull Distribution.

UNIT-IV

Joint Distributions—Discrete and Continuous, Moment Generating Functions.

UNIT- V

Populations and Samples, The Sampling Distribution of the Mean (σ known), The Sampling Distribution of the Mean (σ unknown), The Sampling Distribution of the Variance, representations of the Normal Theory Distributions.

Text Books:

1. Miller & Freund's Probability & Statistics for Engineers: Johnson Richard A., Eastern. Economy Edition, PHI, 7th Edition, 2006

Reference Books:

1. Mathematical Statistics: Freund, J.E.: Prentice Hall, 6th Edition,2002
2. Applied Statistics and Probability for Engineers: Douglas C. Montgomery, & George C. Runger, John Wiley & Sons, Inc., 3rd Edition, 2004

Course Outcomes

Upon successful completion of the course, student will be able to:

- Calculate probabilities and other relevant quantities by selecting suitable probability distributions.
- Work with certain multivariate distributions and derive marginal and conditional probability distributions.

Skill development/Entrepreneurship/Employability:

Knowledge in Probability Distributions and Statistical Analysis. Scope in Mathematical Biology, Theoritical Computer Science, Ergodic Theory, Data Analysis and Macchnine Learning.

Course No: **BMMATH123**	Course Title: **Higher Calculus**	L	P	U
		3	0	3

Course Learning Objectives

- Use calculus to study the paths, velocities, and accelerations of moving bodies
- To study the applications of derivative motion in space
- To understand the frame of mutually orthogonal unit vectors
- To study the functions of more than one independent variable, the way to graph them
- To understand the idea of directional derivatives and the equations of tangent planes and normal lines
- To find extreme values of functions of several variable
- To find the volume of three dimensional shapes using triple integrals
- To calculate the work done by variable forces alone paths in space and rates at which fluids flow along curves and cross boundaries
- To describe the relationship between the way an incompressible fluid flows across the boundary of a plane region and the way it moves inside the region
- To understand Infinite summations

Course Contents:

UNIT-I

Limits, Continuity and Differentiability of vector functions, Velocity & Unit tangent vector, Normal vectors, Curvature, Torsion and the binormal, Tangential & normal components of velocity and acceleration.

UNIT-II

Functions of several variables, Limits and continuity in higher dimensions, Partial derivatives, differentials, linearization, Taylors formula for two variables, Chain rule for derivative, Directions derivatives, Gradient and Tangent planes, Maxima,Minima with application, Polar coordinates: Definition, graphing and conics.

UNIT-III

Double integrals in rectangular coordinates, Double integrals in polar coordinates, Cylindrical and spherical coordinates, Triple integrals in rectangular, cylindrical and spherical coordinates (moments, masses and centroids), Substitution in multiple integrals, Jacobian.

UNIT-IV

Lines integrals, potential & Conservatives fields, Green's, Gauss, and Stokes theorems, Surface area and surface integrals.

UNIT-V

Infinites series, convergence & divergence, Integral, Comparison & Ratio Tests, Alternating series and absolute Convergence.

Text Books:

Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2012.

Reference Books:

1. Thomas G.B. and Finney R. L., Calculus and Analytic Geometry, Pearson Education, 11th ed., 2008.
2. Salas S. L., Einar Hille and Garret J. Etgen, Calculus (One and Several variables), John Wiley, 8th Edition, 1999.

Course Outcomes

After successful completion of the course student will be able to

- Students will learn important tools of calculus in higher dimensions.
- Engineering applications will help the student appreciate the role of the course in B.Tech
- Geogebra software exposure for mathematical problem solving
- Students will become familiar with 2- and 3-dimensional coordinate systems.
- Students will also learn how to represent motion of objects in 3D using vector functions, how to represent velocity and acceleration using vector projections into tangential and centripetal coordinates of acceleration, and how to characterize curves in space by computing arc length and curvature.
- For functions of 3D surfaces, students will be able to characterize aspects of surfaces and volumes using partial derivatives and the gradient vector.
- Partial derivatives will also be used to describe approximating tangent planes to points on surfaces, and how to compute derivatives of multi-dimensional function compositions can be performed using a multidimensional version of the chain rule.
- Evaluating Double and Triple Integrals.

Skill development/Entrepreneurship/Employability:

Capacity in modeling of uncertainity, knowledge in probabililty distributions and statistical methods. Opportunities in Data Analysis, Machine Learning and Higher Studies.

Course No: **BMPHY124**	Course Title: **Physics-II**	L	P	U
		3	0	3

Course Learning Objectives

Develop an understanding of the basic principles of electromagnetism and the application of the principles with emphasis on problem solving skills.

Course Content:

UNIT I

Coulomb's law, continuous charge distributions. Electric field of point charges, continuous charge distributions, field lines, point charge and dipole in an electric field. Flux of a vector field, flux of electric field, Gauss' law, its applications, Gauss' law and conductors.

UNIT II

Electric potential, potential due to point charges and continuous charge distribution, calculating field from potential, potential from field, equipotential surfaces, potential of a charged conductor. Types of materials, conductor in an electric field, Ohm's law, Ohmic materials. Capacitance, calculation of capacitance, capacitors in series and parallel, energy storage in an electric field, capacitor with dielectric

UNIT III

Magnetic interactions, magnetic poles, force on a moving charge, circulating charges, force on a current carrying wire, Hall effect, torque on a current loop. Magnetic field due to moving charge, due to current, parallel currents, field of a solenoid, Ampere's law.

UNIT IV

Faraday's law, Lenz' law, motional emf, induced electric fields. Magnetic dipole and force on a magnetic dipole in a non-uniform field, Magnetization, Gauss' law for magnetism. Inductance, calculating the inductance, energy storage in magnetic field

UNIT V

Equations of electromagnetism, Maxwell's equations, induced magnetic fields and Displacement currents. Concept of photons, Thermal radiation, photoelectric effect. Matter waves, de Broglie's hypothesis, experimental verification by Davison and Germer experiment, uncertainty principle.

Text Books:

1. Physics, Robert Resnick, David Halliday and Kenneth S. Krane Vol. 2, John Wiley, 5th ed., 2002.

Reference Books:

1. Fundamentals of Physics, Robert Resnick, David Halliday and Jearl Walker, John Wiley, 6th ed., 2001.
2. Physics, Cutnell and Johnson, John Wiley, 5th ed., 2001.
3. Introduction to Electrodynamics, David J Griffiths, PHI, 3rd ed., 2002.

Course Outcomes

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

- Understand the main concepts of electromagnetic theory
- Develop the mathematical framework to explore electricity and magnetism
- Apply the mathematical framework quantitatively for solving relevant problems
- Appreciate qualitatively how they play a role in many aspects of daily life.

Course No: **BMTA125**	Course Title: **Scientific Measurements**	L	P	U
		0	4	2

- **List of Physics experiments:**

No.s	Experiments	Duration
1.	Vernier calipers and Screw gauge	1:40 H
2	Graphical Analysis	1:40 H
3.	Error analysis and Graph drawing	1:40 H
4.	Compound pendulum	1:40 H
5.	Parallelogram law of forces and Lami's Theorem	1:40 H
6.	Dispersive power of the material of the a prism	1:40 H
7.	Fly Wheel	1:40 H
8.	Diffraction Grating	1:40 H
9.	Magnetic Field along the Axis of Current Carrying Coil – Stewart and Gees Method	1:40 H
10	Hall Effect	1:40 H

- **List of Chemistry experiments:**

No.s	Name of the Experiment	Duration
1.	Estimation of iron (Fe^{+2}) by Dichrometery	1:40 H
2.	Estimation of copper by Iodometry	1:40 H
3.	pH curve of an Acid Base titration	1:40 H
4.	Dissociation constant of a weak electrolyte by conductometry	1:40 H
5.	Colorimetric estimation of Iron	1:40 H
6.	Estimation of strength of oxalic acid using potassium permanganate as an intermediate solution	1:40 H
7.	Synthesis of Nickel(II)-Dimethylglyoxime complex	1:40 H
8.	Determination of rate constant and activation energy of the given ester catalysed by an acid	1:40 H

Course No: **BMTA126**	Course Title: **Workshop Practice**	L	P	U
		2	4	4

Course Learning Objectives

1. To learn how the physical artifacts we use are manufactured and gain technical knowledge and skills.
2. The practical knowledge is supplemented by the lectures to provide the knowledge and genesis of various manufacturing processes.
3. To check the dimensional tolerances of machined components and acquire knowledge of handling basic machine tools for different applications.
4. To develop skills required for machining components by advanced manufacturing methods like CNC programming.
5. To analyse the difference between conventional and non-conventional manufacturing processes.

Course Contents

UNIT-I

Basics of Manufacturing: Basics, ethics and safety in workshop, Material properties, fracture, selection, mechanical properties, common engineering materials, Metrology, quality, Inspection measuring and gauging, Limits & fits, Examples.

UNIT-II

Metal Cutting Basics: Metal cutting, Machine tools, Cutting tools, Tool material, Types of tools, Tool geometry, Chips, Cutting fluid, Tool life, Lathe machine tool, Turning and other operations,Operating conditions, MRR, Examples.

UNIT-III

Machine Shop Activities: Introduction to other Machines, tools, operating conditions, Shaping & planing machines, Milling machine, types of milling operations, Operating conditions, Milling operations, MRR, Abrasive machine, abrasives, Grinding, Grinding wheel, Grinding machines, fine finishing operations.

UNIT-IV

Sheet metal working: Production of parts by forming processes, Metal forming processes, rolling, extrusion, forging, Punches and dies, Sheet metal operations.

UNIT- V

Mechanical joining processes: Production of parts by casting processes, Mechanical joining, Welding (arc, gas), Soldering, Brazing, Fasteners, Examples, Application of Computers in Manufacturing, CNC programming for machining components using co-ordinate system, Automation, Comparison between conventional machines and NC machines.

Text Books:

1. B S Nagendra Parashar and R K Mittal, Elements of Manufacturing Process, Prentice Hall of India, 2011, 10th reprint.

Reference Books:

1. Campbell J.S., Principles of Manufacturing Materials and Processes, Tata Mc-Graw-Hill, New Delhi, 1999 print.
2. Serope Kalpakjain, Steven Schmidt, Manufacturing Engineering and Technology, Pearson, 7th Edition, 2014.

Course Outcomes

Upon successful completion of the course, student will be able to:

- The course will provide an overview of the techniques and applications of basic manufacturing processes used for producing finished articles from raw materials.
- The course is practice-orientated and requires that basic skills in handling of tools, machines and machine tools used in different manufacturing processes are acquired through the hands-on experience.
- Much of the knowledge in the course is conceptual and this knowledge will be useful in whatever discipline the students are going to specialize.
- **Skill Development / Employability / Entrepreneurship**

Name of the Laboratory: Workshop	
Sl. No.	**Name of the Experiment**
1	Metrology (To measure the Linear and angular measurements with various Measuring Instruments)
2	Fitting (To make a 'L' fit joint by using Mild steel plate)
3	Tin Smithy (To make a Square Box by using Galvonised Iron sheet)
4	Carpentry (To make the Dove tail lap joint by using wooden teak wood)

5	House wiring (To connect and performing the various connections)
6	Machine Shop (To make different operations by using Mild steel rod)
7	Welding (To make a different welding joints by using Arc welding machine)
8	Black Smithy (To make different shapes by using mild steel square rods in Black smithy)
9	Foundry (To make different moulded shapes by using different patterns)
10	Programming and performing on CNC Lathe Machine
11	Plumbing (Demonstration)
12	Demonstration on different machines

Course No: **BMTA127**	Course Title: **Computer Programming II**	L	P	U
		3	0	3

Course Learning Objectives

- To introduce object-oriented programming (OOP) using the Java programming language.
- To learn how to use the Java SDK environment to create, debug and run simple Java programs.
- To introduce Arrays, Abstract Classes, Exception Handling, File I/O and Multithreading.
- To provide hands-on experience in developing Java applications using database connections.

Course Contents

UNIT-I

Introduction to Java: Java Development Kit, Keywords, Identifiers, Class libraries, Key Attributes of OOP, Primitive Data types, Literals, Variables, Scope and lifetime of variables, Operators, Type casting, Operator precedence, Expressions. If Statement, Loops, Nested loops. **Class Fundamentals**: Objects, Reference Variables and Assignment, Methods, Constructors, Parameterized Constructors, new operator, Garbage collection, finalizers, and this keyword.

UNIT-II

Arrays: Multidimensional arrays, Alternative Array declaration syntax, using length member, Constructing Strings, Operating on Strings, Array of Strings, Using a string to control switch statement, Command line arguments, Conditional operator. Controlling access to class members, passing objects to methods, Returning Objects, Method Overloading, Overloading Constructor, Recursion, static keyword, Nested and inner classes, vararags

UNIT-III

Inheritance: Basics, Member access, Constructor and Inheritance, using super keyword, multi-level hierarchy, method overriding, abstract classes, creating and implementing an interface, multiple interfaces. **Package:** Packages and member access, Importing packages, static import

UNIT-IV

Exception: Exception Hierarchy, Multiple catch clauses, catching sub class exception, nested try blocks, throwing an exception, finally, throws, Java's Built in Exceptions. Introduction to I/O, Byte stream and Character stream, Reading and writing files using byte stream, Multithreading: Fundamentals, Life Cycle, Thread class, Runnable Interface, Multiple Threads, Thread priorities, Synchronization.

UNIT-V

Database Connectivity: Overview of RDBMS, Call Level Interface (CLI), JDBC, JDBC Architecture, types of JDBC Drivers, JDBC Connection using Statement, Prepared Statemen and Callable Statement, Scrollable and Updatable Result Set, Inserting & Fetching from BLOB Columns, Managing Transactions in JDBC. **Exploring My Cloud Powered by AWS:** Virtualization, Types of Virtualization, Cloud Containers, Client server computing, Big Data, Data Analytics, Data Visualization, DBMS, Relational and Non-Relational DBMS, Data Warehouse Basics, HTML basics to design a Web Page, QoS Factors, File System, Load Balancing, and Domain Name System.

Text Books:

1. Java Fundamentals A Comprehensive Introduction, Herbert Schildt, Dale Skrien. Tata McGraw Hill, 1st Edition, 2013.

Reference Books:

2. Java The Complete Reference, Herbert Schildt, 7th Ed. TataMcGrawHill (2007)
3. Programming with Java A Primer, E. Balaguruswamy,3rd Ed,TataMcGrawHill 2007
4. Object Oriented Programming with Java: Essentials and Applications, Rajkumar Buyya, Thamarai Selvi Somasundaram, Xingchen Chu, 1st Ed. TataMcGrawHill 2010
5. Java How to Program, Paul Dietel and Hervey Dietel, 9th Edition

Course Outcomes

After successful completion of the course student will be able to

1. Understand object-oriented programming concepts and basics of java programming
2. Solve real world problems using OOP techniques
3. Understand the use of abstract classes, packages and interfaces.
4. Expand their knowledge of AWS cloud computing models, services and tools through narrative-based scenarios and short interactive tasks.

Skill Development / Employability / Entrepreneurship

COMPUTER PROGRAMMING – II

LIST OF EXPERIMENTS

- Programs to implement pointers and its operations.
- Programs to implement pointers and arrays.
- Programs to implement pointers and strings.
- Programs to implement pointers and structures.
- Programs to implement linked list and its operations.
- Programs to implement stack using arrays.
- Programs to implement stack using pointer.
- Programs to implement queue using arrays.
- Program to implement queue using pointers.
- Programs to implement searching techniques.

Course No: **BMES211**	Course Title: **Electrical Sciences I**	L	P	U
		3	0	3

Course Learning Objectives

- To equip the students with a basic understanding of Electrical circuits and machines for specific types of applications.

Course Contents

UNIT-I

DC Circuits, Kirchhoff's Laws, Mesh & Nodal analysis, D.C transients- First order & second order circuits- The natural and complete Response

UNIT-II

Thevenins & Nortons theorem, Linearity, Superposition, Maximum power transfer theorems, Star- Delta transformation and Concept of Duality

UNIT-III

AC Circuits: Current, voltage, power, - circuit elements R, L and C, phasor diagram, impedance, real and reactive power in single phase circuits, Steady state analysis of AC circuits using Phasor Method, Resonance in series and parallel circuits

UNIT-IV

Transformers- Introduction, Ideal transformer with and without core losses, Transformer circuit model, Determination of parameters and voltage regulation & efficiency.

UNIT- V

Induction motor, circuit model & Rotating magnetic field, Torque-Slip characteristics, Synchronous machines and and applications.

Text Books:

1. Hughes revised by Mckenzie Smith with John Hilcy and Keith Brown, *'Electrical and Electronics Technology', 8th Edition, Pearson, 2012*

Reference Books:

1. D. P. Kothari and I. J. Nagrath, *Basic Electrical Engineering*, Tata McGraw Hill, 2009, Third edition
2. Leonard Bobrow, *Fundamentals of Electrical Engineering*, Oxford University Press 2nd edition 2005
3. W.H.Hayt, J.E. Kemmerly, *Engineering circuit analysis*, McGraw Hill Company, 6th Edition, 2000.

Course Outcomes

- The students shall develop an intuitive understanding of the circuit analysis, basic concepts of electrical machines and be able to apply them in practical situation.

Skill Development / Employability / Entrepreneurship

Electrical Science :

S No	Name of the Experiment
1	Study of measuring instruments
2	Verification of KCL and KVL
3	Super position theorem
4	Maximum power transfer theorem
5	Thevenin's and Norton's theorem
6	Sinusoidal response of RL circuit
7	Sinusoidal response of RLC circuit
8	OC and SC test on single phase transformer
9	Speed control of DC shunt motor
10	Load test on single phase transformer

Course No: **BMES212**	Course Title: **Digital Electronics**	L	P	U
		2	2	3

Course Learning Objectives

- To obtain the knowledge of basic tools for the design of digital circuits.
- To understand the methods, procedures suitable for a variety of digital computers and related applications.

Course Content

UNIT-I

Review of number systems-representation-conversions, Boolean algebra- theorems, sum of product and product of sum simplification, canonical forms-minterm and maxterm.

UNIT-II

Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Quine Mc Cluskey method, Implementation of Boolean expressions using universal gates.

UNIT-III

Combinational logic circuits- adders, subtractors, BCD adder, ripple carry look ahead adders, parity generator, decoders, encoders, multiplexers, demultiplexers, Realization of Boolean expressions- using decoders-using multiplexers. Memories – ROM- organization, expansion. PROMs. Types of RAMs – Basic structure, organization, Static and dynamic RAMs, PLDs, PLAs, PALs, Dual Data RAM (DDR), FPGA

UNIT-IV

Sequential circuits – latches, flip flops, edge triggering, asynchronous inputs. Shift registers, Universal shift register, applications. Binary counters – Synchronous and asynchronous up/down counters, mod-N counter, Counters for random sequence.

UNIT-V

Synchronous circuit analysis and design: structure and operation, analysis-transition equations, state tables and state diagrams, Modelling- Moore machine and Mealy machines, Serial binary adder, sequence detector, state table reduction, state assignment. Hazard; Overview and comparison of logic families.

Text Books

1. M Morris Mano, *Digital Design*, 5th edition, Pearson Education ,New Delhi,2013.

Reference Books

1. Charles H. Roth, Jr, Fundamentals *of Logic Design*, 5th Edition, CENGAGE Learning, India, 2004.
2. ZVI Kohavi and Niraj K Jha, *Switching and Finite Automata Theory*, 3rd Edition, Cambridge University Press, New Delhi, 2011.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Realize complex logic functions utilizing programmable logic.
- Apply the digital design principles in real time applications.

Skill Development / Employability / Entrepreneurship

Electronics:

S No	Name of Experiments / Exercises
1	Study of Electronic Components and Test Equipment's
2	Study of CRO
3	Characteristics of pn junction diode
4	Zener diode characteristics and its regulation
5	Non-linear wave shaping – clippers
6	Non-linear wave shaping – clamper
7	Transistor common-base configuration characteristics
8	Transistor common-Emitter configuration characteristics
9	Half-wave rectifier with and without filters
10	Full wave rectifier with and without filters

Course No: **BMES213**	Course Title: **Engineerng Mechanics**	L	P	U
		3	0	3

Course Learning Objectives

- To introduce the basic principles of engineering mechanics.
- To introduce concepts of equilibrium of bodies at rest and in dynamics, the motion of bodies and the forces that cause them.
- To emphasize analysis and application to practical engineering problems.
- To promote thinking and problem solving capacity of students.

Course Content

UNIT I

Concurrent forces on a plane – composition, Resolution and equilibrium of concurrent coplanar forces, Methods of moment, Friction, Parallel forces in a plane – General case of parallel forces,

UNIT II

Center of parallel forces and center of gravity- centroids of composite plane figure and curves, Moments of inertia - Plane figure with respect to an axis in its plane and perpendicular to the plane – parallel axis theorem

UNIT III

General case of forces in a plane – composition and, equilibrium of forces in a plane –plane trusses – method of joints and method of sections, Principle of virtual work equilibrium of ideal systems

UNIT IV

Rectilinear Translation – Kinematics – Principles of Dynamics - D' Alembert's Principle- Momentum and impulse- work and energy- impact

UNIT V

Curvilinear translation – Kinematics – equation of motion – projectile – D' Alembert's Principle for curvilinear motion – Kinetics of Rotation of rigid body

Text Books

1. S Timoshenko & D.H Young , "*Engineering Mechanics*"McGraw Hill, 4th Edition

Reference Books

1. Fundamental of Engineering Mechanics: S. Rajesekharan& G. SankaraSubramanium ; Vikas Publishing House Pvt. Ltd., (2nd Edition)
2. Engineering Mechanics : K.L Kumar; Tata McGraw Hill, 4th Edition
3. A K Tayal, Engineering Mechanics, Umesh Publication, Delhi, 14th Edition.

Course Outcomes

Upon successful completion of this subject students should be able to:

- Apply the concepts of equilibrium to system of forces on rigid bodies.
- Simplify and clarify mechanics problems using free body diagrams.
- Analyze equilibrium of rigid bodies with frictional forces.
- Determine force couples, centre of gravity and moment of inertia of rigid bodies.
- Determine simple dynamic variables and solve simple dynamic problems involving kinematics, energy and momentum.
- Analyze simple statically determinate structures such as beams, pin jointed trusses and pin jointed frames subjected to various loading and supporting conditions.

Course No: **BMECON214**	Course Title: **Principles of Economics**	L	P	U
		3	0	3

Course Learning Objectives

The course aims to provide to the students an insight into the scientific & analytical methods, techniques and tools of economics, a precise and comprehensive coverage of fundamental concepts in economics; and give suitable examples to expose him/her to possibilities of applications of these concepts in business and economic policy.

Course Content

- Introduction to Economics
- Application of Supply & Demand & Elasticity
- Demand and Consumer Behaviour
- Production & Business Organization
- Analysis of Costs
- Input Pricing by marginal productivity
- Perfectly Competitive Markets
- Imperfect Competition and its polar case of monopoly
- Oligopoly and Monopolistic Competition
- Externalities, Public Goods & Imperfect Information
- Macroeconomic concerns and its components
- GDP, Growth, Unemployment & Inflation
- Multiplier, Fiscal Policy at work
- Monetary Policy at Work and Money Supply.
- Open Economy

Text Books

1. Principles of Economics, Case E. Karl & Fair C., Pearson Education, 6th Edition, 2002.

Reference Books

1. Economics, Samuelson & Nordhus, TMH, 16th Edition, 1998.
2. Principles of Economics, Lipsey, RG & K.A. Chrystal, Oxford University Press, 9th Edition, 1999

Course No: BMMATHC215	Course Title: **Complex Variables**	L	P	U
		3	0	3

Course Learning Objectives

- Identify and construct complex-differentiable functions.
- Use the general Cauchy integral theorem and formula.
- Use conformal mapping.
- Express functions as infinite series or products.

Course Content:

UNIT I: Regions in the Complex plane, Functions of Complex Variable, limits.Mappings, Theorems on limits, Continuity.

UNIT II: Derivatives, Analytic Functions, Cauchy-Riemann equations, harmonic functions, Exponential, logarithmic functions, complex exponents, Complex Trigonometric, Hyperbolic functions and their inverses.

UNIT III: Contour integrals, Anti derivatives, Cauchy theorem, Cauchy Integral Formula,

UNIT IV: Morera's theorem, Liouville's Theorem, Maximum Modulus Principle, Convergence of sequences of series, Taylor's and Laurent series,

UNIT V: Residues poles and zeros of analytic functions, Applications of residues, Conformal mapping, Fourier Transforms and Z Transforms.

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, Latest Indian Edition

Reference Books:

1. Complex Variables and Applications, J.W. Brown, R.V. Churchill, Mc Graw-Hill, 7th ed, 2003.

2. Complex analysis for Mathematics & Engineering, , John H Mathews & Russel W Howell, Jones & Barlett Publishers, 2001

3. NPTEL Videos http://nptel.ac.in/courses/111103070/

Course Outcomes

Upon successful completion of the course, student will be able to:

- Define continuity and differentiability for complex functions,
- Prove the Cauchy-Riemann equations and apply them to complex functions in order to determine whether a given continuous function is complex differentiable,
- Compute the radius of convergence for complex power series,
- Define the complex exponential function, trigonometric and hyperbolic functions and use their basic properties,
- Evaluate integrals along a path - directly from the definition and also via the Fundamental Theorem of Contour Integration and Cauchy's Theorem,
- Compute the Taylor and Laurent expansions of simple functions, determining the nature of the singularities and calculating residues,
- Prove the Cauchy Residue Theorem and use it to evaluate integrals.

Skill development/Entrepreneurship/Employability:
Expertise in Potential Theory, and Harmonic Oscillators. Higher Studies in Mathematical Physics, Harmonic Analysis and other related fields.

Course No: **BMMATH216**	Course Title: **Differential Equations and Fourier Series**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

- To solve first and second order Ordinary Differential Equations by standard methods
- To gain exposure to Engineering applications of Ordinary Differential Equations.
- Introduction to Laplace Transforms for future Engineering courses
- Basics of Fourier series required for Engineering
- Solving important Partial Differential Equations (Simple cases of Wave & Heat equations).

Course Contents

UNIT-I First order differential equations, Reduction of order, second order equations with applications bending of beams and electrical circuits.

UNIT-II Second order homogeneous equations with constant coefficients and the Method of Undetermined Coefficients, Variation of parameters, higher order linear equations.

UNIT-III Power series solutions and ordinary points, Frobenius Method & Regular singular points, Gauss' hyper-geometric equation, Legendre polynomials & Bessel functions.

UNIT-IV Laplace Transform & Inverse Laplace Transform, Convolution of Laplace Transform & application to differential equations,

UNIT- V Fourier series and convergence, Cosine and Sine series, Sturm-Liouville problem, one dimensional Heat and Wave equations and Laplace equations in rectangular form.

Text Books:

Advanced Engineering Mathematics, Erwin Kreyszig 10th Edition, John Wiley & Sons, 2012.

Reference Books:

1 George F.Simmons and Steven. G. Krantz, Differential Equations: Theory, Technique and Practice Tata Mc-Graw Hill, 2007.

2 Elementary Differential Equations, W.E.Boyce and R.C.Diprima, 7th Edition, John Wiley, 2001.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Solve standard ODEs of First and Second Order
- Compute Laplace and Inverse Laplace Transforms for functions in Engineering
- Expand functions in Fourier/Sine/Cosine series
- Obtain series solutions for standard PDEs in two variables

Skill development/Entrepreneurship/Employability:

Capacity to model physical problems and developing solutions through different methods like, Laplace Transforms, Series Solutions, Numerical Methods, and Higher Studies.

Course No: **BMES221**	Course Title: **Electrical Science II**	L	P	U
		3	0	3

Course Learning Objectives

- Characterize semiconductors, diodes, transistors and FETs
- To study behavior of Diod and its applications
- To study characteristics of electronic devices to understand their behavior.
- To design simple analog circuits using BJTs, FETs and Diodes.
- To design and evaluate audio, Power and Feedbak amplifiers.

Course Contents

UNIT-I

Semiconductors: intrinsic and doped; p-n junction. Junction Diode & its characteristics.Defferent types of modeling of Diodes. Ideal Diode and Practical diodes. Zener Diode & its characteristics. Applications of Zener Diode. Application of Practical Diodes: Clamper and Peak to Peak Detector.

UNIT-II

Introduction to transistors, PNP Transistor, NPN transistors and their characteristics & operation.

Types of biasing the transistors.CE & CB Configuaration. Different catergories of operation: active region, Cutoff and Saturation. Application to Digital Logic Circuits. Introduction to JFETs, their operation & characteristics. MOSFETs & its characteristic (Depletion and Enhancement MOSFET). Introduction MOSFET logic gates and characteristics. Introduction CMOS logic gates and characteristics.

UNIT-III

Introduction to JFETs, their operation & characteristics. MOSFETs & its characteristic (Depletion and Enhancement MOSFET). Introduction MOSFET logic gates and characteristics. Introduction CMOS logic gates and characteristics.

UNIT-IV

Biasing the BJT and Amplifier, Small Signal AC Models, Additional Amplifier Principles. FET Amplifier with common source, fixed biasing and self-bias. Biasing Enhancement MOSFETs. Small Signal AC Models, MOSFET feedback amplifiers. Effect of bypass capacitors, FET amplifiers. Class A Power Amplifier, Power terminology, Class B power amplifier maximum output power.

UNIT- V

Ideal Op-amp characteristic, equivalent circuit & Block diagram, Parameters of practical Op-amp, CMRR, skew rate, offset voltage and current Series parallel FB amplifier, non-ideal op-amp.

Text Books:

1. Leonard Bobrow, *Fundamentals of Electrical Engineering*, Oxford University Press, Asian Edition Adapted by Navneet Gupta.

Reference Books:

1. Alan R. Hambley, *Electrical Engineering: Principles and Applications*, Publisher, 6nd Edition 2013.
2. W.H.Hayt, J.E. Kemmerly, *Engineering circuit analysis*, McGraw Hill Company, 8th Edition, 2013.
3. Vincent Del Toro, *Electrical Engineering Fundamentals*, Phi Learning, 2nd Edition.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Study and analyze the behavior of PN junction diodes.
- Characterize the current flow of a bipolar transistor in CB and CE configurations
- Bias the transistors and FETs for amplifier applications.
- Realize simple amplifier circuits using BJT and FET.

Course No: **BMTA223**	Course Title: **Professional Communication**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

The course aims at acquiring the students

- to understand various aspects of business communication.
- to gain knowledge regarding the various ways of assembling information,
- to write clearly and concisely and to present information in an effective manner
- to train them for oral presentation.

Course Contents

UNIT-I

Basics of Communication process, Features of Techincal communication, differences between general purpose communication and technical communication, Verbal and non verbal communication and their differences, understanding and overcoming barriers of communication.

UNIT-II

Definition and characteristic features of a technical report, Classification of reports, Strucutre and Layout of report, Various elements of a report and features of each of the elements, Various ways of collection of data, principles of preparing a questionnaires, Practicing questionnaire preparation, Organization of materials, Preparation of the outline, Formatting techniques.

UNIT-III

Elements of effective writing, Mechanics of writing, Writing styles and use of suitable words and phrases for technical writing according to the context, Revision practices, Principle steps of writing a précis, making notes, abstract and executive summary.

UNIT-IV

Oral presentation features, Use of illustrations, tables and visual aids in presentation and technical writing, Non –verbal aspects in oral presentations, Reading skills for different purposes.

UNIT- V

Distinctive features of memo reports and letter reports, Preparing Notice, Minutes of meeting Brochures,Instructions manual and User's Manual, Understand the difference between Preparing Notice, Minutes of meeting Brochures,Instructions manual and User's Manual, Business Letter formats, layouts and its significance.

Text Books:

1. Koneru. A. (2008).*Professional Communication.* McGraw Hill

Reference Books:

1. Omfort, Jeremy et al (1984). *Business Report in English*. Cambridge University Press
2. Gerson & Gerson (2000). *Technical Writing Process and Product.* Pearson Education.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Understand the aspects of verbal and non verbal communication in its significane in professional and personal communication
- Utilize their knowledge of report writing and write appropriate technical reports.
- Make oral presentations
- Distinguish between various busniness communicational formats and use them appropriately.

Course No: **BMMGTS224**	Course Title: **Principles of Management**	L	P	U
		3	0	3

Course Learning Objectives

The course aims at acquainting the students with various aspects of modern management. During the past two decades a revolution has taken place in the area of management. The new era is one in which entrepreneurship; innovation & technology are seen as the backbone of management. The emphasis is on the modern management essentials, drawing up from the earlier principles & practices, so as to enable the students to be familiar with the basic concepts of management when they enter the professional world.

Course Content

- Introduction to Management: Science, Theory & Practice
- Management & Society: Social Responsibility and Ethics
- Essentials of Planning
- Setting Objectives
- Strategies, Policies & Planning Premises
- Decision- Making
- The Nature of Organizing
- Organizational Structure: Departmentation
- Line/ Staff Authority, Empowerment, & Decentralization
- Managing Change through Manager and Organization Development
- Human Resources Management and selection
- Performance Appraisal & Career Strategy
- Motivation
- Leadership
- Communication
- The System & Process of Controlling
- Control Techniques
- Marketing Management
- Production & Operations Management
- Information Technology
- International Management

Text Books

1. "Essentials of Management", Koontz H. and Weihrich H., 7th edition, Mcgraw Hill Int. ed., 2007.

Reference Books

1. "Management, Principles and Practices for Tomorrow's Leaders", Gary Dessler, 3rd edition, Prentice Hall, 1998.
2. Engineering Management, Fraidoon Mazda, 1st edition, Addison-Wesley, 1999

Course No: **BMAO225**	Course Title: **Optimization Techniques**	L	P	U
		3	0	3

Course Learning Objectives:

- Introduction to optimization techniques using both linear and non-linear programming.
- Students will learn to frame minima maxima problems in the framework of optimization problems.

Course Content:

UNIT-I:

Introduction to Linear Programming, Assumptions of Linear Programming, the Simplex Method in Tabular Form, the Revised Simplex Method, Duality Theory, Primal-Dual Relationships

UNIT-II:
The Transportation Problem, Methods of solutions to transportation problem, The Assignment Problem, Hungarian Metod

UNIT-III:
Dynamic Programming, Characteristics of Dynamic Programming Problems, Deterministic Dynamic Programming

UNIT-IV
Integer Programming, Formulation, the Branch-and-Bound Technique, a Branch-and-Bound Algorithm for Mixed Integer Programming

UNIT-V:
Nonlinear Programming , Graphical Illustration of Nonlinear Programming Problems , Types of Nonlinear Programming Problems , One-Variable Unconstrained Optimization , Multivariable Unconstrained Optimization , The Karush-Kuhn-Tucker (KKT) Conditions for Constrained Optimization.

Text Books:

1. F.S.Hillier, G.J. Lieberman, Introduction to Operations Research, 9e, TMH, 2012

Reference Books:

1. H.A. Taha, Operations Research- An Introduction, 7e, PHI,

2. Ravindran, Phillips, Solberg, Operations Research: Principles and Practice, 2e John Wiley & Sons, 2007

Course Outcomes:

By the end of the course, students should be able to:

- Cast minima/maxima problems into optimization framework.
- Learn efficient computational procedures to solve optimization problems.

Skill development/Entrepreneurship/Employability:

Expertise in modeling of economic, business and industrial problems. Ample scope in industry, marketing, business, production management and research and development.

Course No: **BMES226**	Course Title: **Structure and Properties of Materials**	L	P	U
		3	0	3

Course Learning Objectives

- The course is interdisciplinary in nature, predominantly covering the fields of physics, chemistry, mechanical and metallurgical engineering
- The course is offered to students of all branches of engineering, and provides an excellent understanding of the structure of materials at the atomic and microscopic level
- The main objective is to show how the type of bonding and crystal structure affects properties of metallic, ceramic, electronic and polymeric materials
- The course aims at to establish correlation between processing/Structure/Performance of materials of importance and shed light on interesting materials and their applications

Course Contents

UNIT-I

General understanding of materials science, Bonding forces and their types: Atomic bonding in solids. Crystal structures and systems: Unit cells, crystallographic directions and planes, Crystalline and non crystalline materials, Single crystals and polycrystalline Materials, Metallic structures, Ceramic and polymer crystal structure, Density computations, Linear and planar densities, Polymorphism and allotropy, Imperfections in solids: Impurities in solids, specification of composition, Defects and dislocations, point defects, Linear defects, Interfacial and bulk defects.

UNIT-II

Diffusion in solids: Diffusion mechanisms, steady and non-steady state diffusions, Factors that affect diffusion, Diffusion in Ionic and polymeric materials. Dislocations and strengthening mechanism in metals: Dislocation characteristics, Slip systems, slip in single crystals, plastic deformation of polycrystalline solids, strengthening mechanisms and strain hardening. Mechanical Properties of solids: Concepts of stress and strain, Elastic and Plastic deformation, Hardness

UNIT-III

Structure and properties of ceramics: Mechanical test behavior of ceramics, Types and application of ceramics, Applications and processing of ceramics, Fabrication and processing of glasses: Glasses - Glass forming – properties, heat treatment of glasses and glass ceramics. Polymer structures: Molecular size, shape & structure of polymers, Important Characteristics of polymeric materials, Mechanical behavior, Crystallization and processing of polymers

UNIT-IV

Phases, microstructures, phase equilibrium: Phase diagrams, unary, binary and binary Eutectic phase diagrams, Lever Rule. Iron carbon systems: Fe-Fe_3C phase diagram, development of micro-structure in Fe-C alloys. Kinetics of phase transformations: Avarami rate equation, Correlation of properties to microstructures, Isothermal transformation diagrams - continuous cooling diagrams, Mechanical behavior of Fe-C alloys, tempered martensite

UNIT-V

Thermal properties of materials; Electronic properties: Energy band in semiconductors etc., Piezoelectricity and Ferro electric materials, applications. Magnetic properties: Super conductivity, superconducting materials and applications, Nanotechnology: Carbon Nano Tubes and their applications.

Text Books:

1. Callister's Materials Science & Engineering Adopted by R. Balasubramaniam, Wiley India Pvt. Ltd., 9th Edition, Reprint 2016.

Reference Books:

1. Engineering Materials: Properties and Selection, K.G. Budinski and M. K. Budinski, Prentice Hall of India, 9th Edition, 2008.

2. The Science and Engineering of Materials, Donald R. Askeland and Pradeep P. Phule, 4th Edition, Thomson book Company, 2003.

3. Principles of Materials Science and Engineering, William F. Smith, Mc Graw-Hill 3rd Edition 1996.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Identify bonding in different material types; describe the lattice structure of materials; describe the lattice parameters for 7 crystal systems; specify the Miller indices for the planes in a unit cell of metals, ceramics and polymers. Define isotropy and anisotropy w.r.t. material properties; describe various types of defects and dislocations and interpret atomic structure within the vicinity of grain and twin boundaries.

- Describe the atomic mechanisms of diffusion in metallic, ionic and polymeric materials; distinguish between steady state and non-steady state diffusions; Explain the factors that affect the rate of diffusion; define slip systems and its relation to mechanical properties; Define stress, strain, state Hook's law, Poisson's ratio; Discuss various mechanical properties like strength, toughness, resilience and hardness

- Describe the process used to produce glass-ceramics; describe structure, composition of different types of ionic, covalent ceramics viz. cements, refractories, clay products, abrasives. Compute the flexural strength of ceramics by transverse bending test; Interpret the effect of porosity on strength of ceramics; explain the procedure of thermal tampering of glass; Describe polymer structure, classification based on shape, size, chemistry and molecular configuration; Thermosetting and thermoplastic polymers; Interpret mechanical properties of elastomers

- Describe phase, composition in binary phase diagram of alloys; explain the phase diagram of Fe-C systems and estimate the composition of individual phases Explain the kinetics of phase transformation; describe the microstructure of micro-constituents of iron alloy and cite mechanical characteristics of each; Isothermal cooling and C-C-T diagrams.

- Describe the electronic band structure; electrical conductivity of metals, semiconductors, electronic mobility; Describe the phenomenon of ferroelectricity and piezoelectricity; Describe the phenomenon of superconductivity; Define heat capacity and specific heat, thermal conductivity and thermal stress; Determine the linear coefficient of thermal expansion; explain the phenomenon of thermal expansion from an atomic perspective; Explain the structure, property and applications of nano materials.

Course No: **BMAO312**	Course Title: **Control System**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

- To equip the students with the fundamental concepts in control systems.

Course Content

UNIT-I

Modelling of physical systems: Differential equations of physical systems, mechanical systems and electrical analogies, Electrical systems - Electromechanical systems – Mechanical systems – Thermal systems. Concept of Transfer Function, Block diagrams and reduction methods, Construction of Signal flow graphs; Mason's Gain formula and its applications

UNIT-II

Feedback systems and effect of feedback on sensitivity and system dynamics, Effect of feedback on control systems with disturbance signals. Time domain analysis: Test signals and time domain response of first order system, Response of second order system; time domain specifications, Steady state errors and error constants for various types of systems

UNIT-III

Stability of control systems and effect of root locations, Routh-Hurwitz stability criterion. Concept of root locus and magnitude and angle criteria, Root locus construction rules, Effect of pole-zero additions on the root loci.

UNIT- IV

Frequency domain analysis: Bode plot - Polar plot - Nyquist plot - phase-margin - gain margin - Nyquist stability criterion.

UNIT- V

Controller design: Design of P, PI, PID, lag, lead, lead-lag compensator design.

Text Books

1. Katsuhiko Ogata, '*Modern Control Engineering*', 5th Edition, Pearson Education Publishers, New Delhi, 2010.
2. Nagrath I.J. and Gopal M, '*Control Systems Engineering*', 5th Edition, New Age International Publications, New Delhi, 2010.
3. Benjamin C.Kuo and Farid Golnaraghi, '*Automatic Control Systems*', 8th Edition John Wiley & Sons Publications, New Delhi, 2002.

Reference Books

1. Richard C. Dorf and Robert H. Bishop. '*Modern Control Systems*', 12th Edition Pearson Prentice Hall Publications, New Delhi, 2010.
2. Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, '*Feedback Control of Dynamic Systems*', 6th Edition. Pearson Education India Publications, New Delhi, 2008.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Understand the concepts of closed loop control systems.
- Analyze the stability of closed loop systems.
- Apply the control techniques to any electrical systems.
- Design the classical controllers such as P, PI, etc., for electrical systems.

Course No: **MATH211**	Course Title: **Stochastic Processes**	L	P	U
		3	0	3

Course Learning Objectives:

- The course will consider Markov processes in discrete and continuous time.
- Elucidate the power of stochastic processes and their range of applications.

Course Contents

UNIT-I

Introduction to Stochastic processes. Specification of stochastic process, Stationary process, martingales

UNIT-II

Markov chain, Transition probability, Classification of states and chains. Determination of higher transition probability, Stability of Markov chain. Reducible chains, Markov chain with discrete and continuous space.

UNIT-III

Poisson process with related distribution, Generalization of Poisson process,
Birth and death process, Erlang process,

UNIT-IV

Brownian motion, Wiener process, Kolmogorov equations, First passage time distribution of Weiner process

UNIT- V

Renewal process, Renewal process in continuous time, Renewal equations,
Wald's equation, Renewal theorem, delayed and equilibrium renewal process.

Text Books:

Stochastic Process by J. Medhi, New Age International Publication (2nd edition}

Reference Books:

1. Stochastic Process by Shedon M. Ross, Wiley & sons, (2nd edition)
2. Probability, Random Variables and Stochastic Processes, 4th Edn.
A.Papoulis and S. U. Pillai, TMH Publication.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Demonstrate essential stochastic modelling tools such as Markov chains, Poisson process, formulate & solve problems which involve setting up stochastic models.

Skill development/Entrepreneurship/Employability:

Expertise in Analysis of Data, Markov Process, Forecasting. Higher Studies and employability in Big Data Analysis, Computer Simulation, and Machine Learning.

Course No: MATH221	Course Title: **Partial Differential Equations & Systems of ODEs**	L	P	U
		3	0	3

Course Learning Objectives

- Evaluate first order differential equations including separable, homogeneous, exact, and linear.
- Show existence and uniqueness of solutions.
- Solve second order and higher order linear differential equations.
- Create and analyze mathematical models using higher order differential equations to solve application problems such as harmonic oscillator and circuits.
- Solve differential equations using variation of parameters
- Solve linear systems of ordinary differential equations
- Introduce students to partial differential equations.
- Introduce students to how to solve linear Partial Differential with different methods.
- To derive heat and wave equations in 2D and 3D.

Course Contents

UNIT-I

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients.

UNIT-II

Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients (Two Equations in two unknown functions). Simultaneous linear first order equations in three variables, methods of solution.

UNIT-III

Pfaffian differential equations, methods of solutions of Pfaffian differential equations in three variables.

UNIT-IV

Formation of first order partial differential equations, Linear and non-linear partial differential equations of first order, special types of first-order equations, Solutions of partial differential equations of first order satisfying given conditions.

UNIT- V

Linear partial differential equations with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients, Partial differential equations with variable coefficients, Separation of variables, Non-linear equation of the second order.

Text Books:

1. J.Sinha Roy and S. Padhy, A Course on Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi, Ludhiana, 2012.

Reference Books:

1. Differential Equations: Theory, Technique and Practice, George F.Simmons and Steven. G. Krantz, Tata Mc-Graw Hill, 2007.
2. An Elementary Course in Partial Differential Equations, T Amaranath, Narosa Publishing House, 2013.
3. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
4. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi
5. An Introduction to Ordinary Differential Equations, Earl A. Coddington, PHI, 2002.

Course Outcomes

Upon successful completion of the course, students will be able to:

- The student will be able to solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases.
- The student will be able to find the complete solution of a nonhomogeneous differential equation as a linear combination of the complementary function and a particular solution.
- The student will be introduced to the complete solution of a nonhomogeneous differential equation with constant coefficients by the method of undetermined coefficients.
- The student will have a working knowledge of basic application problems described by second order linear differential equations with constant coefficients.
- Solve linear partial differential equations of both first and second order
- Apply partial derivative equation techniques to predict the behaviour of certain phenomena.
- Apply to specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialisation.
- Identify real phenomena as models of partial derivative equations.

Skill development/Entrepreneurship/Employability:

Knowledge in formulating problems involving functions of several variables, creating relevant computer models. Applications in Physics and Engineering problems. Higher studies.

Course No: MATH311	Course Title: **Real Analysis**	L	P	U
		3	0	3

Course Learning Objectives: This course is intended to expose student to the basic ideas of Real Analysis. In particular,

- To learn about Real Numbers and the Axiom of Completeness, Sequences and Limits of Sequences, Infinite Series, Sequences of Functions and Uniform Convergence, Power Series and Taylor Series
- The course is all about mathematical proofs. One has to study examples definitions and theorems. Learn certain proof techniques.

Course Contents

UNIT-I

Review of Algebraic and Order Properties of R, Neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R.

UNIT-II

Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima. The Completeness Property of R, The Archimedean Property, Density of Rational and Irrational numbers in R, Intervals.

UNIT-III

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotonic Sequences, Monotonic Convergence theorem (weierstrass completeness theorem).

UNIT-IV

Cantor's completeness theorem. Subsequences, Divergence Criteria, Monotonic Sub-sequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criteria

UNIT- V

Infinite series, convergence and divergence of infinite series, Cauchy Criteria, Tests for convergence:. Comparison test, Limit Comparison test, Ratio Test, Cauchy's n-th root test, Integral test, Alternating series, Leibnitz test, Absolute and Conditional convergence

Text Books:

1 Methods Of Real Analysis,Richard R. Goldberg, John Willey & Sons,1976.

Reference Books:

1 Introduction to Real Analysis, Fourth Edition, Robert G. Bartle, Donald R. Sherbert, John Wiley & Sons, 2011.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Define the real numbers, least upper bounds, and the triangle inequality.
- Define functions between sets; equivalent sets; finite, countable and uncountable sets. Recognize convergent, divergent, bounded, Cauchy and monotone sequences.
- Calculate the limit superior, limit inferior, and the limit of a sequence.
- Recognize alternating, convergent, conditionally and absolutely convergent series.
- Apply the ratio, root, limit and limit comparison tests.

Skill development/Entrepreneurship/Employability:

Knowledge in mathematical analysis of continuous and differentiable functions which link to subjects like Differential Equations, Functional Analysis and Statistical Physics. Ample scope in research and development.

Course No: **MATH312**	Course Title: **Algebra**	L	P	U
		3	0	3

Course Learning Objectives:

This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of fundamental concepts of algebra which include groups, subgroups, permutations, cosets and the theorem of Lagrange, homomorphism, isomorphism, rings, fields, integral domains and relate these concepts to the number systems, calculus and linear algebra.to study the division algorithm, factor theorem, remainder theorem and unique factorization theorem as they apply to polynomials over a field. Abstract algebra gives a good mathematical maturity and enables to build mathematical thinking and skill.

Course Contents

UNIT-I

Binary algebras, Cyclic monoids, submonoids, Groups, Morphisms, direct products, Examples of Groups, postulates, subgroups, Abelian groups,Groups acting on sets, Permutations, Lagrange's theorem, Normal subgroups.

UNIT-II

Introduction, Integral domains and fields, Fields of quotients, Subrings, Morphism of rings, Direct sums, ideal and quotient rings, Divisibility, Euclidean domains, Unique factorization theorem, Prime and maximal ideals, Gaussian elimination

UNIT-III

The Rings R[x], polynomial rings over fields, Polynomial codes, Advantageous properties, Shift registers.

UNIT-IV

Unique factorization theorem for polynomials, Complete roots of unity, polynomial functions, and Formal derivative.

UNIT- V

Extension of fields, simple extensions, Computation in R[x]/m[x], Existence theorem, Finite fields. Lattices: Lattices and Posets.

Text Books:

Moderen Applied Algebra, Garrett Birkhoff and Thomas C Bartee, CBS Publishers& Distributors, Delhi, 1987.

Reference Books:

Algebra, Hungerford, Thomas W., Graduate Texts in Mathematics, Springer, 1974.

Course Outcomes

Upon successful completion of the course, students will be able to:

- Understand the concepts of groups, group homomorphism and isomorphism and related notions.
- Be familiar with common examples of groups of both finite and infinite order.
- Be able to construct and work with related objects: subgroups, Cartesian products, quotient groups.
- Understand what it means for a group to act on a set.
- Use the axioms that define a ring, and know the basic properties of rings arising from these axioms
- Know how to add and multiply polynomials over arbitrary fields, and be able to use this to define polynomial rings.
- Be familiar with various methods of proof, including direct proof, constructive proof, proof by contradiction, induction.
- Develop skills in creative and critical thinking, problem solving, logical writing and clear communication of mathematical ideas.

Skill development/Entrepreneurship/Employability:

Skill in mathematical operations. Scope in Computing and Higher Studies.

Course No: **MATH313**	Course Title: **Graph Theory**	L	P	U
		3	0	3

Course Learning Objectives

- To understand and apply the fundamental concepts in graph theory
- To apply graph theory based tools in solving practical problems
- To improve the proof writing skills

Course Contents

UNIT-I

Graphs: Basic concepts and graph terminology,

UNIT-II

Representing graphs and graph isomorphism.

UNIT-III

Distance in a graph, Cut-vertices and Cut-edges, Minimum spanning tree.

UNIT-IV

Connectivity, Euler and Hamiltonian paths.

UNIT- V

Planar graphs: Combinational and Geometric Duals, Kuratowski"s graphs, Detection of planarity, thickness and crossing.

Text Books:

1. F.Harary Graph Theory Narosa (Indian Edition) 2002

Reference Books:

1. Narsingh Deo Graph Theory with Applications Prentice Hall India 1986
2. Bollobás, B. Modern Graph Theory (Graduate Texts in Mathematics). New York, NY: SpringerVerlag, 1998. ISBN: 0387984917.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Explain the basic concepts of graph theory.
- apply the basic concepts of mathematical logic
- Describe and solve some real time problems using concepts of graph theory.

Skill development/Entrepreneurship/Employability:

Expertise in analysing network models in electrical, electronics and communication problems. Research and development in Artificial Neural Networks (ANN), Algorithms and Higher Studies.

Course No: **MATH314**	Course Title: **Combinatorial Mathematics**	L	P	U
		3	0	3

Course Learning Objectives

- To acquire standard principles and functions for counting problems
- To use the fundamental facts on Set Partitions and Inclusion-Exclusion
- To familiarize the machinery of Generating Functions
- To develop ways of solving Recurrence Relations
- To initiate the study of Integer Partitions

Course Contents

UNIT-I

Basic counting principles, Permutations and Combinations (with and without repetitions).

UNIT-II

Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers. Principle of Inclusion and Exclusion, Derangements, Inversion formulae.

UNIT-III

Generating functions: Algebra of formal power series, Generating function models, calculating generating functions, Exponential generating functions.

UNIT-IV

Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations.

UNIT- V

Solutions by generating functions. Integer partitions, Systems of distinct representatives.

Text Books:

1. V.Krishnamurthy Combinatorics:Theory and Applications Ellis Horwood Ltd,Chichester,UK 1986

Reference Books:

1 Richard A. Brualdi, Introductory Combinatorics 5th ed Pearson Publishers 2010

2 Marshall Hall, Combinatorial Theory 2nd ed John Wiley 1998

Course Outcomes

Upon successful completion of the course, student will be able to:

- To formulate and solve basic combinatorial problems
- To apply techniques like Formal Power Series and Generating Functions when the problems require more than common sense
- To appreciate the scope of Combinatorial Theory involving other parts of mathematics like Number Theory.

Skill development/Entrepreneurship/Employability:

Expertise in properties of finite structures which have applications in Logic to Statistical Physics, Evolutionary Biology and Computer Science. Scope in Research and Development in Biotechnology, Computational Social Sciences and Optimization.

Course No: **MATH315**	Course Title: **Cryptography**	L	P	U
		3	0	3

Course Learning Objectives

- To understand the fundamentals of Cryptography
- To acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.
- To understand the various key distribution and management schemes.
- To understand how to deploy encryption techniques to secure data in transit across data networks
- To design security applications in the field of Information technology

Course Contents

UNIT-I

Elementary number theory: Prime numbers, Fermat's and Euler's theorems.

UNIT-II

Testing for primality, Chinese remainder theorem, discrete logarithms.

UNIT-III

Finite fields: Review of groups, rings and fields; Modular Arithmetic, Euclidean Algorithms, Finite fields of the form GF(p), Polynomial Arithmetic, Finite fields of the form GF(2).

UNIT-IV

Data Encryption Techniques: Algorithms for block and stream ciphers, private key encryption – DES, AES, RC4; Algorithms for public key encryption – RSA, DH Key exchange, KERBEROS, elliptic curve cryptosystems.

UNIT- V

Message authentication and hash functions, Digital Signatures and authentication protocols, Public key infrastructure, Cryptanalysis of block and stream ciphers.

TEXT BOOKS:

1. William Stallings: Cryptography and Network Security, Pearson 6th edition. 2013
2. Christof Paar, Jan Pelzl, Understanding Cryptography, Springer Verlag, 2010.

REFERENCES:

1. C. Pfleeger and S.L. Pfleeger, Security in Computing, 3rd Ed., Prentice-Hall of India, 2007.
2. Neal Koblitz, A Course in Number Theory and Cryptography, Second Edition, Springer International Edition, 2010.
3. 3. M.Y. Rhee, Network Security, John Wiley and Sons, NY, 2002

Course Outcomes

Upon successful completion of the course, student will be able to:

- Analyze the vulnerabilities in any computing system and hence be able to design a security solution.
- Identify the security issues in the network and resolve it.
- Evaluate security mechanisms using rigorous approaches, including theoretical

Skill development/Entrepreneurship/Employability:

Knowledging in Coding, Decoding, Stream and Block ciphers, Encription and Decription. Scope in Research and Higher Studies in Cyber Security.

Course No: **MATH316**	Course Title: **Statistical Methods**	L	P	U
		3	2	4

Course Learning Objectives

- Using probability as a tool for addressing random variation and statistical relationships.
- Sampling methodology and principles
- Inference and various cases of it
- Exposure to standard nonparametric tests
- Methods of Regression Analysis

Course Contents

UNIT-I

Random variables:- Two Discrete Random Variables-Joint Probability Distributions-Marginal Probability Distributions - Conditional Probability Distributions – Independence. Two Continuous Random Variables - Joint Probability Distributions- Marginal Probability Distributions-Conditional Probability Distributions- Independence

UNIT-II

Sampling distributions & Estimations:- Sampling Distributions-Sampling Distribution of Means -General Concepts of Point Estimation- Unbiased Estimators-Variance of a Point Estimator-standard error-Reporting a Point-Estimator- Mean Square Error of an Estimator-Methods of Point Estimation - Method of Moments-Method of Maximum Likelihood- - Confidence Interval on the Mean of a Normal Distribution, Variance Known- Development of the Confidence-Interval and Its Basic Properties- Choice of Sample Size-One-sided Confidence Bounds-Confidence Interval on the Mean of a Normal Distribution, Variance Unknown - The t Distribution-The t Confidence Intervalon.

UNIT-III

Test of hypotheses:- Statistical Inference for Two Samples-Introduction -Inference For a Difference in Means of Two Normal Distributions, Variances Known -Hypothesis Tests for a Difference in Means, Variances Known-Choice of Sample Size-Identifying Cause and Effect-Confidence Interval on a Difference in Means, Variances Known -Inference For a Difference in Means of Two Normal Distributions, Variances Unknown -Hypothesis Tests for a Difference in Means, Variances Unknown -Choice of Sample Size-Confidence Interval on a Difference in Means, Variances Unknown -Paired t-Test -Inference on the Variances of Two Normal Distributions-The F Distribution - Hypothesis Tests on the Ratio of Two Variances-Error and Choice of Sample Size-Confidence Interval on the Ratio of Two Variances-Inference on Two Population Proportions-Large-Sample Test for $H0 : p1 \_ p2$ -Test for goodness of fit.

UNIT-IV

Designing Engineering Experiments :-The Completely Randomized Single-Factor Experiment-The Analysis of Variance - Multiple Comparisons Following ANOVA- Residual Analysis and Model Checking-Determining Sample Size – Nonparametric Statistics:- Introduction -Sign Test -Description of the Test - Sign Test for Paired Samples -comparison to the *t*-Test-Wilcoxon Signed-Rank Test -Description of the Test-Large-Sample Approximation-Paired Observations- Comparison to the *t*-Test-Wilcoxon Rank-Sum Test-Description of the Test-Large-Sample Approximation - Comparison to the *t*-Test - Nonparametric Methods in the Analysis of Variance- Kruskal-Wallis Test- Rank Transformation.

UNIT- V

Multiple Linear Regression:-Multiple Linear Regression Model-Introduction -Least Squares Estimation of the Parameters-Matrix Approach to Multiple Linear Regression - Properties of the Least Squares Estimators-Hypothesis Tests in Multiple Linear Regression-Test for Significance of Regression-Tests on Individual Regression Coefficients and Subsets of Coefficients-Confidence Intervals in Multiple Linear Regression-Confidence Intervals on Individual Regression Coefficients-Confidence Interval on the Mean Response-Prediction of New Observations- Model Adequacy Checking -Residual Analysis-Influential Observations-Aspects of Multiple Regression Modeling-Polynomial Regression Models- Categorical Regressors and Indicator Variables-Selection of Variables and Model Building-Multicollinearity.

Text Books:

Applied Statistics and Probability for Engineers Third Edition Douglas C. Montgomery, John Wiley & Sons, Inc.

Reference Books:

1. Probability & Statistics for Engineers & Scientists e i g h t h e d i t i on, Ronald E. Walpole Roanoke College, Raymond H. Myers Virginia Polytechnic Institute andState University, Pearson Education International
2. Introduction to the Practice of Statistics SIXTH EDITION, DAVID S. MOORE GEORGE P. McCABE, BRUCE A. CRAIG, Purdue University, W. H. Freeman and Company, New York.

Course Outcomes:

Upon successful completion of the course, student will be able to:

- The student will have the knowledge and understanding of how to apply probability concepts and theorems into real world problems.

Skill development/Entrepreneurship/Employability:

Knowledge in Statistical Analysis, Time Series Analysis and Demand Analysis. Scope in Higher Studies and Employability in Production and Control.

Course No: MATH317	Course Title: **Differential Geometry**	L	P	U
		3	0	3

Course Learning Objectives

- To apply Vector Calculus to the description of space curves
- To use Evolutes and Involutes for deeper study of space curves
- To connect classes of curves with surfaces of Developable and Minimal types
- To introduce the Fundamental Forms to describe variation on surfaces
- To use Principal and Gauss curvatures to distinguish between surfaces

Course Contents

UNIT-I

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae.

UNIT-II

Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curve.

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UNIT-III

Developables: Developable associated with space curves and curves on surfaces, Minimal surfaces.

UNIT-IV

Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms.

UNIT- V

Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigues formula, Conjugate and Asymptotic lines

Text Books:

1. C.E.Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003

Reference Books:

1. T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.
2. B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.

Course Outcomes

Upon successful completion of the course, student will be able to:

- Compute Serret-Frenet frames and understand their significance for curves in space
- Determine Evolutes and Involutes for various curves
- Compute Fundamental Forms and Curvatures for surfaces and appreciate their roles.

Skill development/Entrepreneurship/Employability:

Expertise in collection, analysis, interpretation and presentation of data. Development of Prediction and Forecasting of Economic Activities, Business and Government related problems.

Course No: MATH323	Course Title: **Metric Spaces**	L	P	U
		3	0	3

Course Learning Objectives

- Concept and examples of Metric spaces motivated by the real line
- Convergence and Completeness in Metric spaces
- Continuity in Metric spaces,criteria and characterization
- Fixed Point theorems introduced

Course Contents

UNIT-I

Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences.

UNIT-II

Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantors theorem.

UNIT-III

Subspaces, dense sets, separable spaces. Continuous mappings, sequential criterion and other characterizations of continuity

UNIT-IV

Uniform continuity. Homeomorphism, Contraction mappings.

UNIT- V

Banach Fixed point Theorem. Connectedness, connected subsets of R.

Text Books:

R.R.Goldberg Methods of Real Analysis 2nd edition John Wiley 1976

Reference Books:

1 Tom Apostol Mathematical Analysis 2nd edition Narosa 1998

2. W Rudin Principles of Mathematical Analysis McGraw Hill2008

Course Outcomes

Upon successful completion of the course, student will be able to:

- Understand and apply Real Analysis beyond Advanced Calculus.

Skill development/Entrepreneurship/Employability:

Expertise in defining distance functions on function spaces. Scope in Higher Studies and Research in Quantum Mechanics and Quantum Computing.

Course No: **MATH324**	Course Title: **Rings and Fields**	L	P	U
		3	0	3

Course Learning Objectives

Rings and Fields is a one semester course designed to:

Study fundamental concepts of algebra which include rings, fields, integral domains and relate these concepts to the number systems; to study the division algorithm, factor theorem, remainder theorem and unique factorization theorem as they apply to polynomials over a field and aims to introduce the basic concepts and techniques of Galois Theory.

Course Contents

UNIT-I

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x].

UNIT-II

Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains. Algebraic extension of fields: Irreducible polynomials and Einstein criterion, Adjunction of roots, Algebraic extension.

UNIT-III

Algebraically closed fields, Normal separable extensions: splitting fields, normal extensions. Normal separable extension: Multiple roots, Finite fields, Separable extensions.

UNIT-IV

Galois Theory: Automorphism groups and fixed field s, Fundamental theorem of Galois Theory.

UNIT- V

Application of Galois Theory to classical problems: Roots of unity and Cyclotomic polynomials, cyclic extensions

Text Books:

Modern Applied Algebra, Garrett Birkhoff and Thomas C Bartee, CBS Publishers& Distributors, Delhi, 1987.

Reference Books:

1Algebra, Hungerford, Thomas W.,Graduate Texts in Mathematics,Springer,1974.
2 Topics in Algebra, I.N.Herstein, Wiley India 2012

Course Outcomes

Upon successful completion of the course, student will be able to:

- show familiarity with the concepts of ring and field, and their main algebraic properties;
- use the axioms that define a ring, and know the basic properties of rings arising from these axioms
- know how to add and multiply polynomials over arbitrary fields, and be able to use this to define polynomial rings
- understand the meaning of the highest common factor of two polynomials, the proof of existence of the hcf, the meaning of 'coprime' in the context of polynomials over fields, and be able to apply the Euclidean Algorithm to compute the hcf of two polynomials f and g in Q[x], and find polynomials a, b such that $\text{hcf}(f, g) = af + bg$
- Understand the meaning of the least common multiple of two polynomials, the proof of its uniqueness, and be able to compute lcms in the polynomial ring Q[x].
- correctly use the terminology and underlying concepts of Galois theory in a problem-solving context.

Skill development/Entrepreneurship/Employability:

Knowledge in Algebraic Structures and Modular Arithmatic. Scope in Higher Studies and Research in Computer Arithmatic and Cryptography.

Course No: **MATH325**	Course Title: **Topology**	L	P	U
		3	0	3

Course Learning Objectives

- Set theory as background for topological spaces
- Concept of topology and Connectedness as a topological property
- Compactness, its various forms
- Separation properties and types of topological spaces

Course Contents

UNIT-I

Countable and uncountable set, Infinite sets and the Axiom of choice, Well-ordered sets. Topological spaces, Basis and sub basis for a topology.

UNIT-II

The order, product and subspace topology, closed sets and limit points. Continuous functions and homeomorphism, Metric topology, Connected spaces, connected subspaces of the real line, Components and local connectedness.

UNIT-III

Compact spaces, Basic properties of compactness, Compactness and finite intersection property, Compact subspaces of the real line, Compactness in metric spaces, Limit point compactness, Sequential compactness and their equivalence in metric spaces, Local compactness and one point compactification.

UNIT-IV

First and second countable spaces, Lindel of space, Separable spaces, separable axioms, Hausdorff, Regular and normal spaces.

UNIT- V

The Urysohn lemma, completely regular spaces, The Urysohnmetrization theorem, Imbedding theorem, Tietze extension Theorem, Tychonoff theorem, Stone-Cechcampactification

Text Books:

J.R.Munkres Topology, Prentice Hall 2008

Reference Books:

1 J.L.Kelley General Topology Springer Verlag 1993

2. J.Dugundji Topology Allyn and Bacon 1978

Course Outcomes

Upon successful completion of the course, student will be able to:

- Apply topological concepts to various structures, like groups, vector spaces and algebras.
- Prepare for subjects requiring neighbourhood, continuity and other concepts not in the context of Euclidean space.

Skill development/Entrepreneurship/Employability:

Basic knowledge in Real Analysis and Topology, Shapes of Domains. Scope in modeling the optimal shapes of usable equipment and ergonomics. Higher Studies and Research in Topology Optimization, Manifolds.

Course No: MATH326	Course Title: Advanced Probabilty Theory	L	P	U
		3	0	3

Learning Objectives

- **Basic Lebesgue-Stieltjes measures**
- **Integration and Differentiation theory**
- **Probability models and Kolmogorov consistency**
- **Independence, Borel-Cantelli Lemma**
- **Weak and Strong Laws of Large Numbers**

Course Contents

UNIT-I Measures: Classes of sets. Caratheodory extension of measures. Lebesgue-Stieltjes measures on R. Lebesgue-Stieltjes measures on R2. Completeness of measures.

UNIT-II Measurable transformations. Induced measures, distribution functions. Generalizations to higher dimensions . Integrals, Riemann and Lebesgue integrals . More on convergence.

UNIT-III The Lebesgue-Radon-Nikodym theorem. Functions of bounded variation, Absolutely continuous functions on R. Singular distributions. Decomposition of a cdf. Product spaces and product measures. Fubini-Tonelli theorems.

UNIT-IV Probability Spaces. Kolmogorov's probability model, Random variables and random vectors. Kolmogorov's consistency theorem. Independence, Independent events and random variables. Borel-Cantelli lemmas, tail σ-algebras, and Kolmogorov's zero-one law.

UNIT-V Laws of Large Numbers: Weak laws of large numbers. Strong laws of large numbers. Series of independent random variables.

Text Book: K. B. Athreya and S. N. Lahiri: Measure and Probabilty Theory ,Springer 2006

Reference Books:

1 K. R. Parthasarathy Introduction to Probability and Measure (TRIM no33) Hindustan Book Agency, New Delhi 2005.

2 P. Billingsley Probabilty and Measure (3rd edition) 1995, John Wiley & Sons, New York.

Course Outcomes:

Upon successful completion of the course, student will be able to:

Approach Stochastic Processes from a mathematical background. Likewise advanced Branching Processes.

Skill development/Enterpreneurship/Employability:

Opportunities in Statistical Analysis System (SAS), Employability, and Higher Studies.

Course No: **MATH327**	Course Title: **Continuum Mechanics**	L	P	U
		3	0	3

Course Learning Objectives

- The purpose of the course is to expose the students to the basic elements of continuum mechanics in a sufficiently rigorous manner.
- After attending this course, the students should be able to appreciate a wide variety of advanced courses in solid and fluid mechanics.
- To introduce students to the general analytic machinery of tensor calculus, variational principles and conservation laws in order to formulate governing equations.
- To illustrate the principles of constitutive modelling
- To make students aware of some exact, approximate and numerical methods to solve the resulting equations.

Course Contents

UNIT-I

Vector spaces, index notation, second order tensors: skew symmetric, orthogonal and symmetric tensors, invariants of second-order, directional derivative, Frechet derivative, gradient, divergence, curl, and integral theorems.

UNIT-II

Lagrangian and Eulerian description, deformation gradient, strain tensor, stretchtensors, area andv olume transformation, material and spatial derivative, rate ofdeformation and spin tensors , Reynolds' transport theorem, vorticity and circulation.

UNIT-III

Connservation of mass, conservation of linear momentum, the Cauchy'shypothesis, Cauchy str ess tensor, conservation of angular momentum, first law of thermodynamics.

UNIT-IV

Second law of thermodynamics, governing equations in reference configuration and also for control volume, principle of frame-indifference.

UNIT- V

Necessity of constitutive relations, principle of material frameindifference, material symmetry, thermoelastic solids, hyperelasticity, linear elasticity, thermomechanics of fluids, classical heat-conducting fluids, incompressible fluids.

Text Books:

1. Jog, C.S., Continuum mechanics: Foundations and applications of mechanics, Volume I, Third edition, 2015, Cambridge University Press.
2. Chadwick, P., Continuum mechanics: Concise theory and problems, 1999, Dover Publications, Inc., New York.
3. Gurtin, M.E., An introduction to continuum mechanics, 1981, Academic press, Inc.

Reference Books:

Course Outcomes

Upon successful completion of the course, student will be able to:

- Use tensor algebra and calculus for calculations and derivations in general (curvilinear) coordinates.
- Derive the governing equations of continuum mechanics from Lagrangian and Eulerian viewpoints using the divergence and Reynolds transport theorems and use the same principles to extend the derivations to previously unseen situations.
- Determine whether particular vectors, tensors and derivatives are objective and explain the concept of objectivity.
- Use the Clausis-Duhem inequality to derive thermodynamically consistent constitutive laws and determine any implied constraints.
- Use the general theory to formulate and solve problems in linear and nonlinear elasticity and compressible and incompressible fluid mechanics.
- Solve idealised problems in continuum mechanics analytically in spherical, cylindrical and Cartesian coordinates.
- Be able to convert the physical description of a problem in continuum mechanics into the appropriate governing equations and boundary conditions and, conversely, provide a physical interpretation for the solutions.

Skill development/Entrepreneurship/Employability:

Knowledge in mechanical behavior of materials, modeling of continuous mass. Study of deformation and Tensor analysis.

Course No: **MATH328**	Course Title: **Advanced Combinatorics**	L	P	U
		3	0	3

Course Learning Objectives

- Use of Group Theory for Counting Problems
- Coset techniques for representatives
- Polya theory of Enumeration

Course Contents

UNIT-I

Necklace Problem and Burnside's Lemma.

UNIT-II

Cycle index of a permutation group, Polya's theorems and their immediate applications.

UNIT-III

Binary operations on permutation groups.

UNIT-IV

Further Avatars of Polya's theorem.

UNIT- V

Double coset method for the construction of pattern representatives.

Text Books:

1. V.Krishnamurthy Combinatorics: Theory and Applications Ellis Horwood Ltd, Chichester, UK 1986

Reference Books:

1 Martin Aigner Combinatorial Theory Springer Verlag 1997

2 Marshall Hall Combinatorial Theory 2nd edition John Wiley 1998

Course Outcomes

Upon successful completion of the course, student will be able to:

- Apply Group Theory to advanced enumeration problems.

Skill development/Entrepreneurship/Employability:

Knowledge in combinatorial analysis, finite and infinite expansions. Scope in Higher Studies and Resaerch in Combinatorial Geometry, Game Theory, Analysis of Coplex Networks and Random Graphs.

5. REGISTRATION

The structuring of the courses in terms of lecture hours, lab hours, etc., is done through the timetable for each semester/term. On the first day of the semester/term, every student, whether newly admitted or already on rolls, is required to make his/her own timetable for all the courses for which he/she is permitted to register. The student next completes a process of registration for each of the courses in his/her timetable. It shall be the responsibility of the student to complete his/her registration in person, failing which he/she shall not be permitted to attend classes or use the facilities of the Institute.

Eligibility Conditions for Registration

Every student on the rolls of the institute is required to register for the courses to be taken in the semester. A student is not permitted to register in a semester/term if

(i) He/she has dues outstanding to the institute, hostel, library or any recognized organ of the institute.

(ii) His/her results of the preceding semester/term are withheld.

(iii) He/she has an Incomplete (I) report in the immediately preceding semester/term.

(iv) He/she has been specifically asked to stay away from that semester.

Original Registration

On the first day of the semester, every student must register for all the courses to be taken in the given semester. The Chairperson, Academic Registration and Counseling Division along with his/her team of registration coordinators, ensures smooth completion of the registration process. After ensuring that there is no default of fee payment, every student is given a randomly generated priority number for registration. The order /queue followed by students for registration are based on the priority number. Every student is provided with a master timetable with the following information: course titles, course codes and units of courses offered in the semester, number of sections for each course, timings and venue, common hour details, tests and examination schedules and faculty names. The student is expected to make his/her own timetable exercising his/her choices while ensuring that the sections of his/her choice are still available and there are no clashes in the timings of different courses. The choices that he/she can exercise will in general be decided by his/her priority number. The

registration process is completed once he/she submits the filled in registration card with details of courses taken and the same is approved by the Chairperson.

Conditions for registration of Backlog courses

If a student has not cleared a named course (other than electives) mentioned in his/her semester-wise chart by the time under consideration, then the said course becomes a backlog course until he/she clears it at the next possible opportunity. During registration, the student should first register for all backlog courses which are offered in that semester before taking other courses.

Provisional Registration

A student may be permitted for a provisional registration even if he/she has some outstanding dues. The student can complete his/her registration with the written permission from the Director. The dues must be cleared within the stipulated time decided by the Institute. The provisional registration is subject to cancellation without notice, if the student is found defaulting after the grace period.

Late Registration

Under exceptional circumstances, a student may be permitted to opt for late registration. The student should apply to the Director through Chairperson-Academic Registration and Counseling Division and obtain prior permission for late registration. Late registration is done on the 8th day of the semester. A student who fails to meet the late registration deadline has lost the last opportunity to register for that semester. Students are advised to avoid late registrations as the choice of sections for various courses can be limited by the delay.

Amendment to Registration

The Chairperson-Registration can amend the registration of a student under the following circumstances:

(i) If the registration of a student in a course is not found to be in accordance with the regulations, like a student not fulfilling prior preparation conditions or pre-requisite conditions for a course his/her registration in that course will be cancelled.

(ii) In case of timetable clashes or clashes in tests/examination schedule, the registration is amended by removing the said course(s) from the students registration card.

Substitution of Courses

Course substitution can be done when

(i) Any time within one week from the beginning of the semester, a student requests for substitution of a course in which he/she has already registered, with another course.

(ii) ACC recommends for substitution of one course with another for a student under its purview.

Withdrawal from Courses

(i) If a student desires to withdraw from a course, he/she may submit a formal application for withdrawal within ten weeks from the beginning of the semester.

(ii) In exceptional circumstances, a student may be permitted to completely withdraw from all the courses and drop the semester/term when the Director is satisfied with the reasons that warrant the withdrawal.

Pre-requisite Courses

Certain courses have pre-requisite conditions attached to them which the student should have fulfilled before registering in such courses. If a course is a pre-requisite,then the student should have a valid grade, not a report, in the pre-requisite course

Prior Preparation

For certain courses or a group of courses, a specified prior preparation is required.These requirements are described in the following table.

For first degree students:	
IP I for single/dual degree	Normally all courses in the semesters preceding IP I for his/her program/composite program.
IPII/TS for single/dual degree	All named courses of his/her program/composite program, other than TS/IP-II.
For any other prescribed semester of single / dual degree	All named courses in semesters and terms preceding this set of courses in his/her program / composite program

* If IP-I is delayed by one year for a student with the permission of the appropriate authority, he/she would be permitted to register for CDC's with prior preparation package not including IP I.

6. TEACHING AND EVALUATION

Teaching

The objective of classroom education is to awaken curiosity, generate habits of rational thinking and train students to be independent and face unfamiliar situations. Classroom instructions help a student to organize and correlate facts, comprehend ideas and to use knowledge creatively.

Multi-Section Operations

A number of courses offered in the first two years at IcfaiTech are multi-section in operation and many of these are interdisciplinary in nature. Some of the salient features of multi-section operation are enumerated below:

• Every course, is conducted by a member of the faculty called an Instructor-in-Charge (IC), with the assistance of required number of Instructors - who will partner in meeting the full academic responsibilities and organizational needs of teaching and evaluation.

• The IC with the team of instructors makes a comprehensive plan with respect to the conduct of the course. The team remains in continuous interaction throughout the semester, to ensure smooth operation of the course.

• While the style of teaching may vary from instructor to instructor, the team makes all effort to ensure that the pace of delivery of the content is uniform.

• The question papers, its solutions and detailed break-up of marks for tests/quizzes and other examinations are prepared by the entire team.

To ensure uniformity in marking, a given question is marked by the same instructor for all the students registered in the course. All this ensures that the operational aspects including grading are free from arbitrariness.

Course Handout

For a smooth conduct of a course, the instructors share all the important details of the course, including assessment scheme with students at the beginning of the semester. This is done through a 'Course Handout' that provides information like the

• scope & objectives of the course

• text books, reference books, and other digital resources like NPTEL, SWAYAM

• content and operational aspects (pace, coverage and level of treatment)

• frequency/duration of classes, credits

• components of evaluation like quizzes/tests (announced or unannounced, open-book or closed-book), laboratory exercises, list of experiments, home assignments and their relative weights

• course outcomes

• attendance policy

• policy on make-up tests

• chamber consultation hours

Evaluation Components

Teaching and evaluation form a coherent function and operate on the basis of mutual understanding and trust at IcfaiTech. All components of evaluation are internal; conducted and evaluated by the Instructors/team of instructors handling the course. The evaluation components are evenly spread out in the semester. Various attributes like spontaneous recall, practical application of concepts, ability to work on their own, competence in conceptualized arguments, aptitude to face unfamiliar situations are put to test. The various components of evaluation that the instructor may employ to evaluate a student are tests, quizzes, seminars, presentations, assignments, projects, laboratory-based experiments etc. The evaluation methods, components and their weights depend on the nature of the course. The suggested components normally include two or three written tests, quizzes, and assignments. The quizzes and assignments are interspersed between the tests. All tests and quizzes are conducted during the common hours without disturbing the normal academic schedule. All test and end semester examinations are conducted as per the schedules announced to the students through Course Handouts. One of the components of evaluation (End-Semester examination) is comprehensive enough to include the entire course and is held at the end of the semester. The written examination normally consists of objective questions, short-answer

questions, descriptive-answer questions, problems etc. The pattern and type of questions may vary depending on the nature of the course.

Component	Weights	Duration
Test-I	15%	50 minutes
Test-II	15%	50 minutes
Test-III	15%	50 minutes
Assignments/quizzes/presentations/projects	15%	
End Semester Examination	40%	3 hours

Evaluation components and their weights for a typical theory course.

Evaluation and Feedback on performance

Just as evaluation is done in a continuous and transparent manner, feedback on performance in the evaluation components is also made available at regular intervals. The answer scripts are promptly evaluated and shown to the students. The performance of the students with reference to the highest, lowest and average marks is discussed in the class. Solutions with the marking scheme are displayed immediately on the department notice board after every test and examination.

In case of any subjectivity in the evaluation, or discrepancy from the discussed/displayed evaluation scheme, or any totaling errors in the answer script, the student reserves the right to request for a rechecking or retotalling.

Mid-semester grading for each course, based on the evaluation components conducted until the middle of the semester, is made available to the students. This grade alert will help the students to improve their performance in the remaining evaluation components.

Attendance Policy

Every student is normally expected to maintain a minimum of 75% attendance in every course for which he/she is registered. In courses with both theory and laboratory components, the student must maintain a minimum of 75% attendance in both the components.

The IC/instructor in consultation with the Chairperson Academics can recommend to the Director, IcfaiTech for condonation up to a maximum of 10% for those students who face genuine difficulty in maintaining 75% attendance.

Condoning process has the following steps:

- Instructor-in-Charge/instructors make a list of students with attendance between 65 and 75%.
- The data of these students on performance indicators like marks in tests, quizzes and assignments is examined.
- Assignments and tasks are designed for each student to make up for deficiency in academic performance and the shortage of attendance.
- who complete the task to the satisfaction of the Instructor are permitted to appear for the examination.

If a student does not write the end-semester examination or is not permitted to take the end-semester examination in any course, he/she will be given RRA report. He/she will be required to Register Again (RRA) for the course when it is next offered.

Periodic alerts given by the instructors regarding attendance must be taken seriously and every effort made to reach the required attendance.

Make-up Policy

If a student anticipates a genuine difficulty in meeting the date of component of evaluation, he/she should take the IC/Instructor into confidence prior to the event and request for a makeup. Whenever a student misses a component of evaluation for genuine and unanticipated reasons and has therefore not taken prior permission, the student must immediately after the test approach the IC/Instructor with a request for make-up.

If the IC is satisfied with the request, a make-up test/examination would be conducted one week after the date of the missed component of evaluation.

The students must note that there will be no makeup for laboratory experiments, lab exams, quizzes and presentations.

Unfair Practices in Examinations/Academics

Students must not resort to unfair means during any evaluation component. Any of the following events will be considered as unfair practice(s) during examinations/evaluation.

a) Possessing unauthorized materials like notes or slips in pockets, vanity bags and purses.

b) Having notes and formulas written on the body.

c) Using cell phones or programmable calculators.

d) Copying from other students.

e) Allowing/enabling other students to copy from one's paper/computer screen.

f) Taking or giving any kind of assistance from/to other students.

g) Communicating with the students in or outside the exam hall.

h) Going out of the examination hall other than to the rest room.

i) Plagiarism in project work/assignments.

In the judgement of the Invigilator, if a student has indulged in unfair means in the examination hall, the following steps are taken by the invigilator:

• The student is asked to surrender the answer book and any possible material evidence and leave the exam hall.

• A report is filed with the Director, IcfaiTech after handing over the answer book with material evidence. The examination committee conducts an enquiry where the student is given opportunity to defend himself.

Use of unfair means if established, would result in one of the two punishments:

a. Cancellation of registration (RC) for the course in which use of unfair means was established.

b. Cancellation of registration for the course along with suspension for a full semester. Suspension for a full semester implies that the student cannot register for any course offered in that semester.

7. GRADING

The IcfaiTech system emphasizes on continuous and regular evaluation, which includes numerical marking in grading the student. At the end of a semester, letter grades are awarded to the students based on their overall performance in the course. These grades are relative to the performance of all the students evaluated for that course.

Letter Grades

The list of letter grades, the grade points associated with them and their qualitative meanings are given below:

Letter	Qualitative Grade	Points attached
A	Excellent	10
B	Good	8
C	Fair	6
D	Poor	4
E	Exposed	2

In order to arrive at letter grades, the histogram based on the total marks in a particular course for all the students pursuing the course is made. The histogram normally shows clusters, gaps between clusters or dips between clusters. The grading in the course is guided with reference to the highest, lowest, average marks, and the gaps and dips between clusters of students. In courses where the registered number of students runs into hundreds, the range of C grade usually covers the average marks. This may however not be case when the histogram is skewed, and the average marks of the class is unusually high or low.

In case of absence of clear gap between clusters, the grade border may be drawn in a dip in the cluster. The decision on whether the students appearing on the borderline are pushed to the higher grade or to the lower grade is taken on a case by case basis. Some of the factors that guide the instructor in grading the borderline students are attendance, participation in the class and overall attitude.

In courses with a small number of registered students, the instructor opts for absolute grading. In such cases, the instructor announces to the students at the beginning of the semester, the anticipated mark ranges for various grades.

Reports

At the time of final grading, in certain cases, the Instructor-in-Charge can report certain events/facts in place of letter grades. These reports are not to be construed as grades. The various reports listed below are elaborated in the subsequent paragraphs.

1. Incomplete (I)

2. Grade Awaited (GA)

3. Withdrawn (W)

4. Registration Cancelled (RC), Required to Register Again (RRA) and Discontinued from the Program (DP)

5. Not Cleared (NC).

Incomplete (I)

An Instructor-in-Charge who finds that a student has not fulfilled some requirement of a course before the deadline for transmitting the grades, is satisfied that the student is able to transmit a grade or a report without this fulfillment; can use his/her discretion to give the student an opportunity.

The Instructor-in-Charge can within the deadline, send a report 'I' (Incomplete) for the student and also inform the student of the same. It shall be the responsibility of the student to contact the Instructor-in-Charge and fulfill the requirement for replacement of the 'I' report within two weeks after the end of the semester; failing which the Instructor-in-Charge will communicate whatever grade/report is possible for that situation.

Grade Awaited (GA)

'GA' is given in situations where operational and practical difficulties may cause a delay in transmitting of a grade or a report. Some instances when GA is given are as follows:

(i) pending case of unfair means

(ii) pending case of indiscipline

(iii) for IP courses where the student is at an off campus center and the dissemination of information between the Institute and the IP center is delayed

(iv) if due to genuine reasons a student is unable to appear for end-semester examination on the scheduled date and his/her request for make-up has been granted After the case has been decided, or the IP grade getting transmitted or the makeup taken and evaluated, the GA report is converted into a valid grade or report.

Whenever the report GA appears in the grade sheet, it must be converted into a letter grade or a report before the next semester registration.

Withdrawn (W)

A student may seek withdrawal from course(s) in a semester for any of the following reasons:
(i) The student is unable to attend classes for the course(s) for a genuine reason.

(ii) The student is unable to cope up with the normal load and withdraws from the course(s) to reduce his/her academic load for the semester.

Request for withdrawal should be made to Chairperson-Academics, within ten weeks of commencement of the semester. In case of withdrawal within the stipulated time, the grade sheet/transcript of the student will indicate 'W' (withdrawn) against the course(s) from which the student has withdrawn his/her registration. If the withdrawal is made after the due date, the event will be reported as 'RC'. In either of the situations, the student will have to register for the course(s) at the next offer and obtain a valid letter grade.

Registration Cancelled (RC), Required to Register Again (RRA), Discontinued from Program (DP)

If a student's registration for a course has been cancelled, it will be reported in the grade sheet as 'RC'. The following are the situations when an RC report is issued:

(i) Cancellation is recommended as a part of disciplinary action against the student for resorting to unfair means during examination or other unprofessional behavior

(ii) Cancellation is recommended due to less than the minimum required percentage of attendance.

(iii) Cancellation is recommended if a provisionally admitted student fails to submit the proof of necessary documents required for registration and/or does not satisfy the minimum eligibility requirements for the admission within the prescribed time limit.

(iv) Cancellation is recommended when a student persistently and/or deliberately does not pay his/her dues.

RC itself has many contextual meanings:

(i) When it is clearly known that the student is required to register again in the same course, the event will be reported as RRA (Required to Register Again).

(ii) If RC amounts to discontinuation from the program, it will be reported as DP (Discontinued from the Program).

(iii) If the cancellation of registration is not reported either as RRA or as DP but as RC, it does not necessarily mean that it is free from any constraint but that the meaning of the constraint must be construed from the context in which the RC is reported.

Not Cleared (NC)

If a student continued to remain registered in a course (with or without lab component) but gave the instructor inadequate opportunity to evaluate him by not attending the quizzes/ tests/examinations/lab sessions and other components of evaluation, or by appearing in the same for the sake of appearing, without applying himself to the task at hand, the student will be given NC (Not Cleared). It is to be noted that a NC cannot be ignored, except under the situations described in (ii) and (iii) below:

(i) Whenever a student gets a NC report in a course which is in the compulsory package of his/her program, he/she is required to register again in the same course and get a valid grade.

(ii) If a student has a NC report in an elective course, he/she can either repeat the course to get a valid grade or ignore it to choose another course. However, a student must get valid grades in at least the prescribed number of electives in his/ her program.

(iii) If a student record has a NC report in a course which remains unaccounted for, after a process of transfer has been completed, although it will not be possible for him/her to wipe out the NC report from his/her transcript, he/she can still graduate. (iv) If a student gets a NC in IP/Thesis, he/she will be required to register in the same for one more semester.

Cumulative Grade Point Average (CGPA)

The Cumulative Grade Point Average (CGPA) is used to describe the overall performance of a student in all courses in which he/she is awarded letter grades since his/her entry into the Institute. It is also used for the declaration of division when the program is completed.

CGPA is the weighted average of the grade points of all the letter grades received by the student from his/her entry into IcfaiTech and is computed as follows:

$$CGPA = \frac{\Sigma u_i g_i}{\Sigma u_i} = \frac{(u_1 g_1 + u_2 g_2 + u_3 g_3 + \ldots)}{(u_1 + u_2 + u_3 + \ldots)}$$

Where u1 , u2 , u3 , ... denote units associated with the courses taken by the student and g1 , g2 , g3 ..... denote grade points of the letter grades awarded in the respective courses. Reports will not alter the CGPA, since the same are not accounted for in the CGPA calculations.

When a student repeats a course in which he/she has already received a grade, as soon as a new grade is obtained, it will replace the earlier one in the calculation of CGPA. It is to be noted that only the latter grade in a course would be considered for the calculation of CGPA and not the better of the two grades.

Grade Sheet

A student's grades, reports, CGPA, etc., at the end of every semester/term will be recorded on a grade sheet, a copy of which will be issued to him/her. The grade sheet will be withheld when a student has not paid his/her dues or when there is a case of breach of discipline or unfair means pending against him/her.

While registration with approval of the appropriate authority is a token of permission to pursue studies, the grade sheet is a complete record of the outcome of what was intended in the registration. The various grades and reports discussed in the handbook will be appropriately used to tally the grade sheet with the registration data. It would be evident that this tally between what was registered for and what was obtained in terms of grades and reports will apply to all courses except for any course which was originally registered for, but subsequently replaced by another course through substitution.

The tally is made on a course by course basis at the end of the term to determine which of the courses have been cleared. A course is deemed to have been cleared if the student obtains a grade in the course. However, mere clearing of the prescribed courses does not tantamount to fulfilling the requirements of graduation.

While all grades secured, reports and other pertinent information for a semester are given in a grade sheet, the chronologically organized information from the grade sheets of a student with necessary explanation constitutes his/her transcript, which is issued at the time he/she leaves the institute or on request at an intermediate point.

Minimum Academic Requirements

The education philosophy of IcfaiTech interlinks and at the same time distinguishes between the performance of a student in a single course and his/her cumulative performance. Accordingly, the student of the first-degree program has to maintain the expected minimum academic requirement at the end of each semester.

They are as follows:

(i) A student should not have secured more than one 'E' grade in the semester.

(ii) A student should have CGPA of at least 4.50.

(iii) A student should have at least cleared with his/her latest performance, such courses (counted from the point of his/her entry into the Institute) as are prescribed for a period that corresponds to two-thirds of the number of semesters spent by him/ her since his/her entry into the Institute with reference to his/her current program. This means that at any stage of reckoning, the student should not have spent more than 50% extra time than what is prescribed for him/her up to that stage.

Academic Counseling Committee (ACC)

The minimum academic requirements that every first-degree student should meet at the end of every semester are mentioned above. Failure to meet even one of these requirements will automatically bring the student under the purview of the ACC or the designated authority.

The ACC will take immediate charge of the student and ask him/her to follow a specific path so that he/she can be rehabilitated at the earliest. The student under ACC will not undergo

normal registration process but will be guided by the ACC in selection of the courses for the semester registration.

Once a student has been placed under the purview of the ACC, he/she should continue to be under its direct guidance until,ACC after being satisfied with his/her overall progress and performance, declares him/her to be outside its purview. All decisions of the ACC shall be final.

Students under the purview of ACC are cautioned from time to time if they fail to improve in the following stages.

Warning: A student, who comes under the purview of the ACC for the first time due to a CGPA between 4.2 and 4.5 is warned to take studies seriously and improve the performance in order come out of ACC list by the next semester.

Severe Warning and Reduction in Course Load: If a student has CGPA between 3.0 and 4.2 or continues to remain under the purview of the ACC in the subsequent semester, he/ she would be severely warned. The ACC, based on its evaluation of the student, decides that the student would not be able to cope up with the normal load of courses for the semester. The ACC will work out a package of courses with reduced load for the ensuing semester, so that the student gets a chance to improve and come out of the purview of the ACC.

The implication of a reduced load is that the period of study gets extended.

Probation: If the advice and guidance of the ACC is not taken seriously by the student,and he/she continues to give deteriorating performance, he/she might be given a last chance and kept on probation during the next semester. During this semester his/her progress will be closely monitored.

Discontinued from Program: If a student on probation during a semester fails to improve his/her performance to the satisfaction of the ACC and his/her CGPA falls to below 3.0, he/ she would be Discontinued from the Program (DP) and would be asked to leave IcfaiTech.

It must be noted that any student under the purview of the ACC found to be involved in any act of indiscipline or unfair means in examination at any time would be immediately asked to discontinue from the program. It should therefore be the single-minded objective of the student to fulfill the minimum academic requirements stipulated,thus enabling himself/herself to be declared outside the purview of the ACC at the earliest.

Graduation Requirements

A student is deemed to have fulfilled the requirement of graduation for the first-degree program when he/she satisfies the following conditions-

(i) Has cleared all the courses prescribed for him/her in his/her program.

(ii) Has obtained a minimum CGPA of 4.5.

(iii) Has remained outside the purview of the ACC or has been declared outside its purview.

(iv) Has overcome all the consequential stipulations of an NC report; except where there is NC report in an elective course over and above the prescribed number of elective courses or in a course which has ceased to be a part of his/her current program because of transfer of program.

A student is deemed to have become eligible for the Bachelors degree if, in addition to the above requirements he/she has no case of indiscipline or unfair means pending against him/ her. If a student has outstanding dues against him/her to be paid to IcfaiTech, the student hostel or any other recognized affiliate/ associate organization of IFHE, his/her degree will be withheld until the said dues are cleared.

Certification

The following classification based on CGPA will be made and mentioned in the graduation certificate of the first Degree program student.

Distinction	CGPA 9.00 or above
I Division	CGPA 7.00 or more but less than 9.00
II Division	CGPA 4.50 or more but less than 7.00

Every student is expected to familiarize himself with the following documents associated with academic progress and program completion: Grade Sheet: Grade sheet is a complete record of courses done, grades obtained by the student, showing GPA and CGPA and other information for a semester. Students can obtain duplicate copies of grade sheet on payment of nominal fee.

Transcript: Transcript is chronologically organized information of courses, grades,GPA, CGPA obtained in various semesters during the Program which is issued on successful

completion of the Program. Students can obtain additional transcript on payment of ` nominal fee. Provisional Certificate: Students who fulfill the graduation criteria will be given a provisional certificate before the convocation.

Degree Certificate:

Students who fulfill the graduation criteria will be awarded the Degree certificate at the formal convocation.

Awards

All students who successfully complete the prescribed course work and examinations will receive their degree from IFHE.

Gold and Silver medals will be awarded to the students scoring the first rank and second rank respectively on completion of the program. A student against whom disciplinary action has been taken or has any backlog of course(s) will not be eligible to get merit scholarship/medals.

S. Vijayalakshmi

REGISTRAR
ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deemed-to-be-University established under section 3 of UGC Act, 1956)