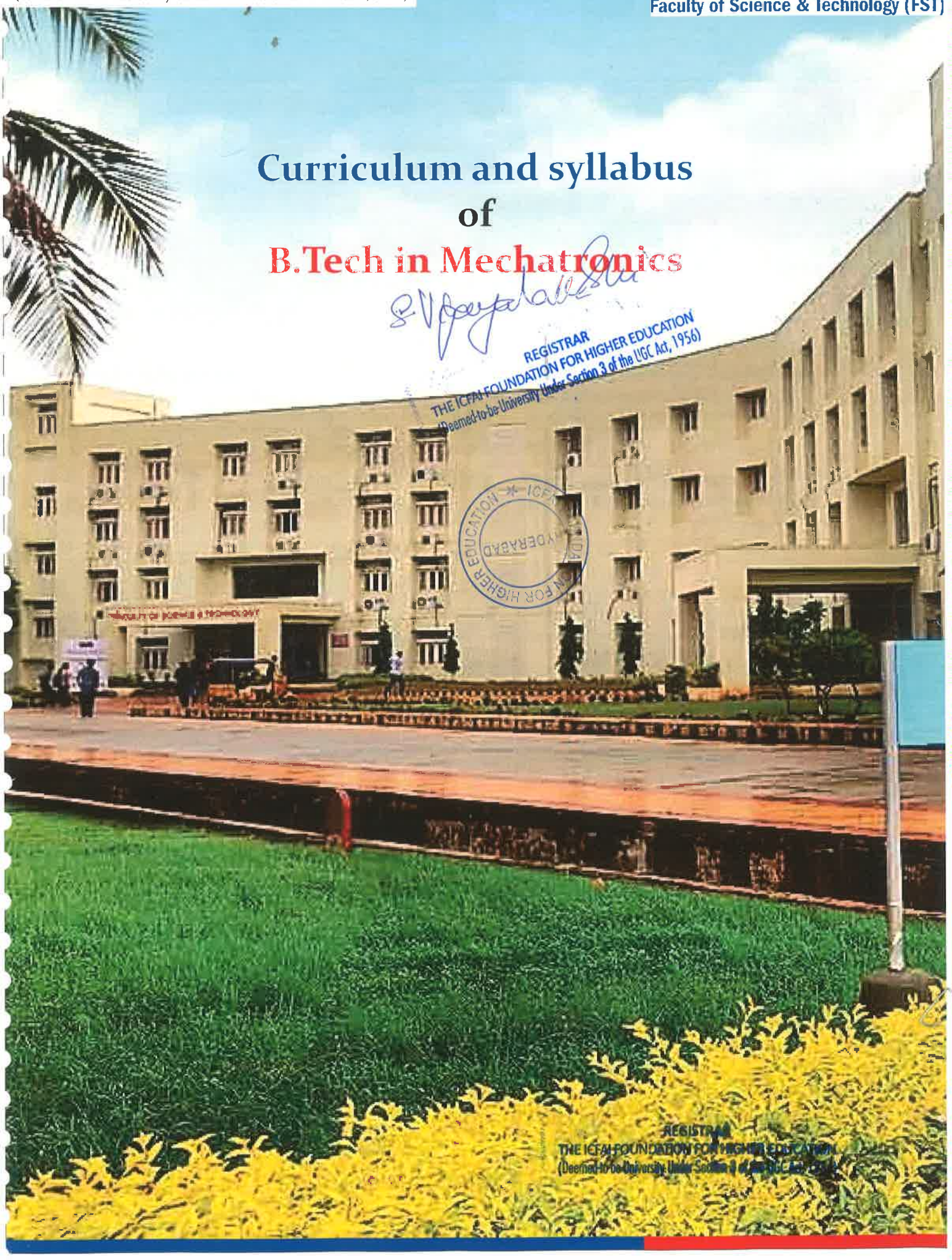
ICFAI Foundation for Higher Education
(Deemed-to-be University under Section 3 of the UGC Act, 1956)

IcfaiTech
Faculty of Science & Technology (FST)

Curriculum and syllabus
of
B.Tech in Mechatronics



All the precautions have been taken to print the Course Curriculum accurate. However, mistakes if any will be corrected as and when noticed. The University reserves the right to include/exclude any content at any point of time during the progression of the course.

REGISTRAR
THE ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deemed-to-be-University Under Section 3 of the UGC Act, 1956)

ICFAI FOUNDATION FOR HIGHER EDUCATION HYDERABAD

Contents

Item #	Description	Page#
1	Introduction	4
2	B.Tech Mechatronics Program Structure	14
3	Course Descriptions	17
4	Handouts	32
5	Registration	153
6	Teaching & Evaluation	156
7	Grading	161

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 be a top ranking University of choice for students, staff and corporates, recognized for excellence in Higher Education and Research especially relevant to social needs.

The mission of the Deemed University is to offer world class, innovative, career-oriented professional postgraduate and undergraduate programs through inclusive technology- aided pedagogies to equip students with the requisite professional and life skills as well as social sensitivity and high sense of ethics. The University will strive to create an intellectually stimulating environment for Research, particularly in areas bearing on the socio-economic and cultural development of the state and the nation.

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

STATEMENTS OF PEOs, POs AND PSOs

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.

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 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

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1	Ability to design, evaluate and built on innovative mechatronic systems to solve the Engineering problems by integrating mechanical, electronics and systems engineering
PSO2	Ability to pursue their higher studies and or research
PSO3	Ability to excel in his/her professional career as an employee or employer.
PSO4	Ability to apply the learned knowledge for the development of intelligent systems to contribute to the societal needs

Table 8: Mechatronics - Semester-wise pattern

Year	Course Code	Semester-I	L	P	U	Course Code	Semester-II	L	P	U
I	MECCHEM111	Chemistry	3	0	3	MECES121	Thermodynamics	3	0	3
	MECEGL112	English Language Skills	3	0	3	MECAO122	Probability & Statistics	3	0	3
	MECMATH113	Linear Algebra	3	0	3	MECMATH123	Higher Calculus	3	0	3
	MECPHY114	Physics I	3	0	3	MECPHY124	Physics II	3	0	3
	MECTA115	Engineering Graphics	2	4	4	MECTA125	Scientific Measurements	0	4	2
	MECTA116	Computer Programming I	3	0	3	MECTA126	Workshop Practice	2	4	4
	MECEVS117	Environmental Science	2	0	2	MECTA127	Computer Programming II	3	0	3
	Total No of Credits				**21**	**Total No of Credits**				**21**
II	**Semester-III**					**Semester-IV**				
	MECES211	Electrical Sciences I	3	0	3	MECES221	Electrical Sciences II	3	0	3
	MECES212	Digital Electronics	2	2	3	MECTA222	Engineering Measurements	1	8	4
	MECES213	Engineering Mechanics	3	0	3	MECTA223	Professional Communication	3	0	3
	MECECON214	Principles of Economics	3	0	3	MECMGTS224	Principles of Management	3	0	3
	MECMATH215	Complex Variables	3	0	3	MECAO225	Optimization Techniques	3	0	3
	MECMATH216	Differential Equations & Fourier Series	3	0	3	MECES226	Structure & Properties of Materials	3	0	3
	MEC211	Elements of Mechatronics	3	0	3	MEC221	Kinematics & Dynamics of Machinery	3	0	3
	Total No of Credits				**21**	**Total No of Credits**				**22**
SUMMER TERM	**IP 221 INTERNSHIP PROGRAM I (for Internship option only)**									**5**
III	**Semester-V**					**Semester-VI**				
	MECAO311	Numerical Methods	3	0	3	–	Humanities Elective	3	0	3
	MECAO312	Control Systems	3	0	3	MEC321	Mechatronics System Design	3	0	3
	MEC311	Introduction to Robotics	3	0	3	MEC322	Actuators, Drives & Sensors	3	0	3
	MEC312	Materials for Mechatronic Systems	3	0	3	MEC323	Manufacturing Processes	3	2	4
	MEC313	Instrumentation & Measurement	3	0	3	MEC324	Micro Electro Mechanical Systems	3	0	3
	MEC314	Micro Processors & Controllers	3	2	4		Elective (1)	3	0	3
		Special Project / TIP	0	0	3		Special Project / TIP	0	0	3
	Total No of Credits				**22**	**Total No of Credits**				**22**
IV	**Semester-VII**					**Semester-VIII**				
	IP401/	Internship Program II			20	–	Electives (4)			18
	TS401	Thesis & Seminar				–	Humanities Elective (2)			
	–	Electives (4)			18	IP401/	Internship Program II			20

	–	Humanities Elective (2)		TS401	Thesis & Seminar	
	Total No of Credits		20/18	Total No of Credits		18/20
Total No of Credits						172

Table : Discipline Core Courses for the B.Tech. Programs

Course Code	Course Title	L	P	U
MEC211	Elements of Mechatronics	3	0	3
MEC221	Kinematics & Dynamics of Machinery	3	0	3

Table : Compulsory Discipline Courses for the B.Tech Programs

Mechatronics				
Course Code	Course Title	L	P	U
MEC311	Introduction to Robotics	3	0	3
MEC312	Materials for Mechatronic Systems	3	0	3
MEC313	Instrumentation & Measurement	3	0	3
MEC314	Micro Processors & Controllers	3	2	4
MEC321	Mechatronics System Design	3	0	3
MEC322	Actuators, Drives &Sensors	3	0	3
MEC323	Manufacturing Processes	3	2	4
MEC324	Micro Electro Mechanical Systems	3	0	3

Table : List of electives for B.Tech. (Mechtronics)

1) Robotics Specialization

Course	Course Title	L	P	U
MEC401	Advances in Robotics	3	0	3
MEC402	Haptics	3	0	3
MEC403	Computational Motion Planning	3	0	3
MEC404	Humanoids	3	0	3
MEC405	Human Robot Interaction (HRI)	3	0	3
MEC406	Mobile Robotics	3	0	3
MEC407	Unmanned Aerial Vehicles	3	0	3
MEC408	Autotronics	3	0	3

2) Bio-Robotics Specialization

Course	Course Title	L	P	U
MEC409	BioMechanics	3	0	3
MEC410	BioMechatronics	3	0	3

MEC411	Protein Kinematics	3	0	3
MEC412	Neural Computation	3	0	3
MEC413	Soft Robotics	3	0	3

3) Medical Robotics Specialization

Course	Course Title	L	P	U
MEC414	Medical Devices	3	0	3
MEC415	Tissue Modelling	3	0	3
MEC416	Medical Image Processing	3	0	3
MEC417	Cognitive Robotics	3	0	3
MEC418	Surgical Robots	3	0	3
MEC419	Machine Perception	3	0	3

4) Manufacturing Specialization

Course	Course Title	L	P	U
MEC421	Nano Electro Mechanical Systems	3	0	3
MEC422	Smart Materials	3	0	3
MEC423	CNC Technology	3	0	3
MEC424	Computer Integrated Manufacturing	3	0	3
MEC425	Hydraulic and Pneumatic Systems	3	0	3

5) List of Humanities Electives

Course	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.Tech Program Course Description
Semester-wise Institute Courses

Course Code	Course Title	L	P	U	Course Description
MECCHEM111	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.
MECEGL112	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
MECMATH113	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.
MECPHY114	Physics I	3	0	3	Momentum and impulse; two and many particle system;

Course Code	Course Title	L	P	U	Course Description
					Rotational kinematics and dynamics; work and energy; conservation principles; oscillations and wave motion; interference, diffraction and polarization.
MECTA115	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.
MECTA116	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
MECEVS117	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
MECES121	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.
MECAO122	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);

Course Code	Course Title	L	P	U	Course Description
					sampling distributions.
MECMATH123	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, 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
MECPHY124	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.
MECTA125	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.
MECTA126	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.
MECTA127	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

Course Code	Course Title	L	P	U	Course Description
					Fundamentals and Services, AWS Analytics and Database Services, AWS Developer and Management Tools, AWS Storage Services, AWS Networking and Content Delivery Services.
MECES211	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
MECES212	Digital Electronics	2	2	3	Number systems and machine representation, Boolean 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
MECES213	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.
MECECON214	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
MECMATH215	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.
MECMATH216	Differential	3	0	3	First order differential equations, Reduction of order,

Course Code	Course Title	L	P	U	Course Description
	Equations & Fourier Series				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.
MECES221	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 transistors, MOSFETs, MOSFET Logic gates, Complementary MOSFETs, BJT Amplifiers, FET amplifiers biasing and small signal analysis ,Frequency response, power amplifiers, IC amplifiers, Operational amplifiers
MECTA222	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.
MECTA223	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.
MECMGTS 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.
MECAO225	Optimization Techniques	3	0	3	Optimization of functions of one and more variables

Course Code	Course Title	L	P	U	Course Description
					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
MECES226	Structure & Properties of Materials	3	0	3	Study of the basic properties of materials in relation to their molecular structure; emphasis on the structure of metallic, polymeric and ceramic materials in relation to their mechanical, electrical, electronic and chemical properties, methods of imparting desirable properties to materials by inducing changes in molecular structure; property requirements and material selection, criteria for widely ranging service conditions.
MECAO311	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.
MECAO312	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
MECHS311	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 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
MECHS312	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.
MECHS313	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.
MECHS314	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.

Course Code	Course Title	L	P	U	Course Description
MECHS315	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.
MECHS316	Professional Ethics	3	0	3	Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.
DS491 CE491 CS491 EC491 EE491 ME491 MEC491	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.
IP 221	Internship Program I	0	0	5	This course is run during the summer term at various industries and is of about 8 week duration.
IP 401	Internship Program II	0	0	20	This course is run during one of the two semesters in the final year and is a part of adjoining summer vacation. The duration of this program is about five and half months. Students will be working at industries on the live projects under the supervision of the FST faculty.
TS 401	Thesis & seminar	--	--	--	TS 401 is a required course for all the students with thesis option.
TIP 491/TIP 491	**Technology Innovation Project**	0	0	3	A unique opportunity for the students in the form of a course that facilitate the combination of academics with the industry by involving an in-depth innovation, investigation under the supervision of mentor from Industry and a faculty member for performing the real-life projects with the support from various organizations. Students working in groups will be required to perform research, customer and problem discovery, ideation, concept creation and validation, and technical implementation for a real-world challenge. The specific time-bound based on the students registered for the course will be graded based on the performance feedback from both the industry and the

Course Code	Course Title	L	P	U	Course Description
					Faculty supervisor. The student will be able to improve the skills and knowledge for improving written and oral communication with indicative content which includes innovation methodology, customer & problem discovery, problem validation, innovation experiments with innovative presentations.

B.Tech Mechatronics Program (MEC)
Course Description

Course Code	Course Title	L	P	U	Course Description
MEC211	Elements of Mechatronics	3	0	3	The course presents a comprehensive knowledge of mechanical and electronic systems. The major topics include system terminology, various electrical elements and circuits, semiconductor electronic devices, digital devices, signals, conversions, conditioning, and integrated circuits. This course also emphasizes on various mechanical activating systems along with their sensory and controlling devices. Integration of various mechatronic elements and programming of different micro controllers are also discussed. Finally, this course helps students to work on mechatronic systems in household appliances.
MEC221	Kinematics & Dynamics of Machines	3	0	3	The course covers fundamentals and principles of kinematics and dynamics of mechanisms and machines. Main topics include the fundamentals of kinematics, statics and dynamics of robot manipulation, planar and spatial mechanism, linkages: analysis and synthesis, drive mechanisms: cams, gears and gear trains, dynamic force analysis and dynamics of rigid bodies. Students nominally working in team are expected to create, analyze and model any basic or newer mechanisms or machine for specific application.
MEC311	Introduction to	3	0	3	The purpose of this course is to introduce you on robotics in practice, autonomy and robotic systems. Manipulator kinematics and dynamics, modeling, motion planning and trajectory generation, obstacle avoidance are the key topics to be covered. The students should be able to model

Course Code	Course Title	L	P	U	Course Description
	Robotics				robotic manipulator and perform the simulation by making use of ADAMS or MATLab. Students will be able to design and fabricate working robotic systems in a group-based project if introduced.
MEC312	Materials for Mechatronic Systems	3	0	3	This course provides a comprehension of materials used in mechanical and electronic systems. The main topics include ferrous and non-ferrous metals, non-metallic materials and fundamental properties and testing of these materials. The course also covers various materials used in electronic systems such as dielectric materials, magnetic materials, semiconductor materials, materials for electrical applications and special purpose materials.
MEC313	Instrumentation & Measurements	3	0	3	Instrumentation and Measurements course is designed for comprehensive treatment of the principle of operation, applications, and limitations of instruments (digital and analog, electrical and mechanical) and measurements are discussed. Instrument calibration is also discussed as well as power and energy measurement. Mechanical measurement systems like motion, pressure, flow, temperature, vibration etc can be briefed. Concepts on data acquisition system, feedback measurement systems will be discussed.
MEC314	Micro Processors & Controllers	3	2	4	The course cover to introduce the architecture and operation of typical microprocessors and micro controllers, identify a detailed s/w & h/w structure of the Microprocessor, to familiarize the user with the programming and interfacing of microprocessors and micro controllers and analyze the data transfer information through serial & parallel ports, to provide strong foundation for designing real world applications using microprocessors and micro controllers.
MEC321	Mechatronics System Design	3	0	3	This course is intended to integrate principles of mechanics, material science and manufacturing processes to the design of components. Because of the emphasis upon integration of mechanical and electronics, this course will center around conception, operational principles, component selection, modeling, analysis, integration, simulation, integrated design and testing issues associated with mechatronics systems design.
MEC322	Actuators, Drives & Sensors	3	0	3	This course provides an introduction to theory and application of Actuators, Drives and Sensors used in mechartonic systems. Electric drives like servo and stepper motors, hydraulic and pneumatic drives, piezoelectric and shape memory alloy actuators will be discussed. Discussion on Mechanical transmission components in mechatronics systems will be extended. Students should get familiarize with Sensor (strain gauge, tachometers, temperature, opto-electronic, ultrasonic, .etc)

S.Vijayalakshmi

Course Code	Course Title	L	P	U	Course Description
					used in mechatronics engineering.
MEC323	Manufacturing Processes	3	2	4	The course aims to teach the fundamentals of manufacturing processes and systems in mechanical and mechatronics engineering, including traditional and advanced manufacturing technologies. This course aims to develop the following attributes: to understand the fundamental principles of manufacturing technologies for the above mentioned engineering areas; to gain the ability to select existing manufacturing processes and systems for direct engineering applications; to develop ability to create innovative new manufacturing technologies for advanced industrial applications; to develop ability to invent new manufacturing systems. Laboratory exercises on manufacturing process are also components of the course.
MEC324	Micro Electro Mechanical Systems	3	0	3	This course is offered to gain basic knowledge on MEMS (Micro Electro Mechanical System) and various fabrication techniques. This enables students to design, analyze, fabricate and test the MEMS based components. Topics include, Introduction to MEMS, application of MEMS, Micro machining, planar – thin film processing, etching, surface finishing, fabrication, micro magnetic actuators, polymer and optical MEMS, MEMS sensors and Bio-MEMS.
MEC324	Machine Perception	3	0	3	Machines perceive the surroundings and their own movements so that they accomplish navigation and manipulation tasks. In this course, students study how images and videos acquired by cameras mounted on machines/robots are transformed into representations like features and optical flow. Such 2D representations allow image processing then to extract 3D information about surroundings. They also understand how grasping objects is facilitated by the computation of 3D posing of objects and navigation can be accomplished by visual odometry and landmark-based localization.
MEC401	Advances in Robotics	3	0	3	This course provides comprehensive advances in robotics. The course will be covering flexible manipulators, protein kinematics and tissue modeling, artificial mussels, autonomous vehicles, medical, rehabitative and assistive robots, multi robot systems, bio inspired robots … and not limited to. Students should emphasize on current challenges that scientists and technologists are addressing in robotics. They should present a seminar or produce a term paper or poster on advances in robotics.
		3	0	3	This course is intended in touch for use in technological systems like human-machine interface. This course will cover different aspects of Haptic Technology including the Haptic System, Haptic Rendering, Teleoperation,

Course Code	Course Title	L	P	U	Course Description
MEC402	Haptics				Affective Haptic, and its different devices and applications. Students will learn how to design and program their own applications in different haptic/probe systems.
MEC403	Computational Motion Planning	3	0	3	The goal of this course is to provide fundamentals in motion planning, formulation in various ways to model different situations. Discussions on basic path planning algorithms using potential functions, roadmaps and cellular decompositions. We also look at the recent advances in sensor-based implementation and probabilistic techniques, including sample-based roadmaps, rapidly exploring random trees, Kalman filtering, and Bayesian estimation. Throughout the course, we will discuss the aspects of the problem that make planning challenging.
MEC404	Humanoids	3	0	3	The course aims at giving the students a basic understanding of the theory of humanoid robots, i.e. bipedal walking robots with an approximately humanlike shape, and practical knowledge concerning humanoid robots, through a humanoid construction project.
MEC405	Human Robot Interaction (HRI)	3	0	3	This course will focus on the emerging field of Human-Robot Interaction (HRI). This draws primarily from: robotics, AI, human-computer interaction, and cognitive psychology. The primary goal of HRI is to enable robots to successfully interact with humans. This course will cover topics related to social intelligence: learning, teamwork, planning, dialog, emotion, embodied intelligence, etc. For each topic, readings and lectures will cover (1) what's known about how this ability arises in human intelligence, and (2) state-of-the-art approaches to building computational systems with this type of social intelligence.
MEC406	Mobile Robotics	3	0	3	This course will introduce mobile robotics literature, wheeled and legged locomotion, stability of mobile robot, typres of wheels and or legs, number synthesis etc. The course content includes feedback control, control architectures, challenges like energy issues, terrain characteristics, slip free motion..etc
MEC407	Unmanned Aerial Vehicles(UAV)	3	0	3	This courses provides comprehensive introduction to UAV, history of UAV, classification, Unmanned Aircraft Systems, models and Prototypes, System Composition, applications, design of UAV systems, Standards and Regulatory Aspects, Specifications, payload calculation, radio control frequency, ground test, analysis and trouble shooting, mini and micro UAVs, future Prospects and Challenges.
MEC408	Autotronics	3	0	3	This course provides an overview of the Engine

Course Code	Course Title	L	P	U	Course Description
					technologies, Vehicle Mobility and Automotive Control Systems. The course content includes automotive electronic components, sensors and activators in automobiles, electric power generation and distribution, cruise control, traction control, emissions control, driver interface, entertainment and communication systems. Students can use engine-modeling software to explore effects of valve timing and intake tuning and conduct experiments with vehicle emissions, ignition timing, engine mechanisms, engine controls, and emissions control. Students will also learn On-Board Diagnostics to communicate with the electronic systems in an automobile and extract essential system performance information.
MEC409	BioMechanics	3	0	3	This course focuses upon the development of techniques of human movement analysis from structural and functional points of view and incorporates principles of mechanics as they apply to the analysis of human motion. The course provides an overview of musculoskeletal anatomy, the mechanical properties and structural behavior of biological tissues, and biodynamics. Specific course topics include structure and function relationships in tissues and organs; application of stress and strain analysis to biological tissues; analysis of forces in human function and movement; energy and power in human activity.
MEC410	BioMechatronics	3	0	3	Bio mechatronics is the growing interdisciplinary science that integrates mechanical, electronics, computer science, and embedded systems with biology and neuroscience to develop prostheses and assistive technologies for patients with neuromuscular- skeletal disorders. In this course a number of areas of interest including: sensors, actuators and artificial intelligence for control application like Measurement of blood pressure, Gas analyzers: pH of blood, Smart actuators for biological applications will be covered. A number of specific topic will also be included in the course i.e. auditory and optical prostheses, artificial hearts and active and passive prosthetic limbs, respiration systems, medical imaging, robotic surgery and the biorobotic systems (hardware & signal processing) that underpin their operation.
MEC411	Protein Kinematics	3	0	3	Introduces the fundamentals of biology for an engineer. Covers mechanisms and biomechanics of DNA, proteins, cells, amino acid chains in protein. This course leads to understand of multi body system with large links. Discussion also extended to classical model of protein in a serial chain. 50 -500 residues assumed to be rigid bodies

Course Code	Course Title	L	P	U	Course Description
					with 2 dof between two residues. Students should be able to understand parallel computing algorithms for N (1000) links for use in large multi body systems (such as protein).
MEC412	Neural Computation	3	0	3	The goal of this course is to provide an introduction to the mathematical theories of learning and computation by neural systems. The Course is designed for those who are interested in applying knowledge of neural systems, brain function, and modeling to research in human cognition, perception, sensory and motor systems as well as the design of bio-inspired and biologically plausible robotic systems. Discussion continues to the application of computational models into real-world robotic and interactive systems such as robot companions for hospitalized children and for elderly care.
MEC413	Soft Robotics	3	0	3	Soft, elastically-deformable machines and electronics will dramatically improve the functionality, versatility, and biological compatibility of future robotic systems. In contrast to conventional robots and machines, these soft robots will be composed of elastomers, gels, fluids, gas, and other non-rigid matter. Students will explore emerging paradigms in soft robotics and study their design principles using classical theories in solid mechanics, thermodynamics, and electrostatics. Specific topics include artificial muscles, peristaltic robotics, soft pneumatic robotics, McKibben muscles, fluid-embedded elastomers, and particle jamming.
MEC414	Medical Devices	3	0	3	Study of the design and control of robots for medical applications. Focus is on robotics in surgery and interventional radiology, with introduction to other healthcare robots. The course contains 1. Identification and description different types of medical robots and their potential applications 2. Developing the analytical and experimental skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions 3. providing knowledge with the state of the art in applied medical robotics and medical robotics research
MEC415	Tissue Modelling	3	0	3	For designing robotic surgery systems, most challenging problem is modeling tissue. This course introduces concepts like tissue structure and function, tissue compression, mechanical forces, heat, tool-tissue interactions etc. Developing tissue matrix structure, modeling tissue stiffness, mathematical and computational modeling for scaffold design and fabrication and application of tissues modeling to specialized tissues and organs etc discussed.
MEC416	Medical Image Processing	3	0	3	This course provides a uniquely practical, application-focused introduction to medical image processing and

Course Code	Course Title	L	P	U	Course Description
					analysis. It has been focused on segmentation, classification and registration, imaging techniques, reconstruction techniques and image artifacts, and discusses the archival and transfer of images; reviews an expanded selection of techniques for image enhancement, feature detection, feature generation, segmentation, registration, and validation; examines analysis methods in view of image-based guidance in the operating room.
MEC417	Cognitive Robotics	3	0	3	Cognitive robotics is the programming of robots to enable the achievement of goals in environments that require cognitive capabilities such as perception, attention, anticipation, planning, memory, learning, and reasoning. The course discusses artificial intelligence techniques, as well as insights from cognitive science. The techniques and topics will include algorithms for allowing a robot to: Monitor itself for potential problems (both observable and hidden), scheduling tasks in time, coming up with novel plans to achieve desired goals over time, dealing with the continuous world, collaborating with other (autonomous) agents, dealing with risk, and more. Discussion extends to *Tekkotsu*.
MEC418	Surgical Robots	3	0	3	This course presents an overview of surgical robotics in practice and research with topics including the historical backdrop, specific robotic platforms, end-wrist manipulation kinematics, Camera integration, knot analysis, dexterous manipulation in various platforms such as general surgery, laparoscopic surgery, ENT, heart, gastrointestinal, gynecology, and bone and spine. This course also touches upon principles of tele-manipulation and software architecture of a robotic system named *da-Vinci*. This course will also expose students to some of the contemporary research happenings in surgical robotics, facilitating field visits on specific application areas.
MEC419	Machine Perception	3	0	3	Machines perceive the surroundings and their own movements so that they accomplish navigation and manipulation tasks. In this course, students study how images and videos acquired by cameras mounted on machines/robots are transformed into representations like features and optical flow. Such 2D representations allow image processing then to extract 3D information about surroundings. They also understand how grasping objects is facilitated by the computation of 3D posing of objects and navigation can be accomplished by visual odometry and landmark-based localization.
MEC421	Nano Electro Mechanical Systems (NEMS)	3	0	3	The course presents an overview of NEMS in practice and research with topics including introduction, synthesis methods of nanoparticles, microscopic studies of nanostructures, structural characterization techniques, and applications of nanomaterials.
MEC422	Smart Materials	3	0	3	The course develops an essential understanding of structure-property relationship of smart materials, as well as their applications in pragmatic situations. This course

Course Code	Course Title	L	P	U	Course Description
					also helps the students develop capability to design functional structures using smart materials and provides students an opportunity to learn the new knowledge through project approaches. Furthermore, this course touches upon various novel materials such as hybrid composites, shape memory alloys, magnetorheological fluids, electrorheological materials, nanotubes and highlights the inter-disciplinary nature of these materials.
MEC423	CNC Technology	3	0	3	This course provides a comprehensive knowledge about CNC Technology. The major topics include evolution and principles of advanced machines such as NC, DNC and CNC machines, constructional features and specifications, and drives and controllers of CNC system. This course also develops students to write CNC part programs for various operations based on product geometry. This course exposes students to various methodologies for CNC system maintenance and troubleshooting.
MEC424	Computer Integrated Manufacturing (CIM)	3	0	3	Computer Integrated Manufacturing is a manufacturing approach in which computers are used to control the entire production process. The course explains integration of all the elements of CIM system in a typical manufacturing unit. This course covers the topics on fundamental elements, computer aided design and manufacturing, protocols, file formats, business function and shop floor data collection. This course also covers computer aided process planning.
MEC425	Hydraulic and Pneumatic Systems	3	0	3	The course focuses on hydraulic, electro-hydraulic, pneumatic and electro-pneumatic systems. The major topics include basic theory, various components and their construction and functional details, and symbols and troubleshooting methods used in pneumatic and fluid power circuit diagrams. This course also covers controllers associated with various hydraulic systems. The students will be exposed to design techniques and analysis tools of certain industry prevalent hydraulic and pneumatic systems.

4. Institute Core Courses Handouts

Course No: **MECCHEM111**	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.

Course No: MECELS112	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.

Course No: MECMATH113	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

Course No: **MECPHY114**	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.

Course No: **MECTA115**	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

Course No: MECTA116	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.

Course No: MECEVS117	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.

REGISTRAR
THE ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deemed-to-be-University Under Section 3 of the UGC Act, 1956)

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.

Course No: MECES121	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: MECAO122	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.

Course No: MECMATH123	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.

Course No: MECPHY124	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: MECTA125	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: MECTA126	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.

Course No: MECTA127	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.

Course No: MECES211	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.

Course No: **MECES212**	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.

Course No: **MECES213**	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: ECON214	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: MECMATHC215	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.

Course No: MECMATH216	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

Course No: MECES221	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: MECTA223	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: MECMGTS224	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: MECAO225	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.

Course No: MECES226	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: **MECTA 222**	Course Title: Engineering Measurements	**L**	**P**	**U**
		1	**6**	**4**

Course Learning Objectives

- To give introduction to the experimental methods and measurement techniques.
- To train the students in the operation of various instruments and equipments and the measurement of various parameters in electronics and mechanical engineering.

UNIT -I:

Generalized Measurement System, Calibration, Standards, Dimensions and Units, Impedence Matching, Experiment Planning, Causes and Types of errors, Error Analysis, Uncertainty Analysis, Evaluation of uncertainties, Method of Least Squares, The Correlation Coefficient, Multiple regression, Standard deviation of mean, Graphical Analysis and Curve fitting, Choice of Graph Formats, General considerations in Data Analysis

UNIT-II:

Basic analog meters, Basic digital meters, Basic input circuits, The Electronic Voltmeter, Digital voltmeters, The Oscilloscope, Variable resistance, LVDT, Capacitive Transducers Photo electric effects, Hall effect Transducers, Digital Displacement Transducers, Comparison of analog &digital instruments

UNIT-III:

Area measurements, Graphical measurement , Planimeter, Graphical and Numerical Methods for Area measurement, Mechanical pressure-measurement devices, Dead weight tester, Bourdon tube, Diaphragm & Bellow Gages, Bridgman Gage, Low-Pressure Measurement, McLeod Gage, Ionization Gage,Alphatron.

UNIT-IV

Flow measurements, Positive-Displacement methods, Flow obstruction methods, Sonic nozzle, Drag effects, Hot-wire and Hot-film Anemometers, Magnetic flowmetersFlow – visualization methods, Laser Doppler Anemometer, Smoke methods, Pressure probes, Impact pressure in supersonic flow.

UNIT-V

Temperature measurements, Temperature scales, Ideal-gas thermometer, Temperature measurements by mechanical effects, by electrical effects, by radiation, heat transfer effect, transient response of thermal systems, thermocouple compensation, Temperature measurements in high flow speed flow.

Concepts of Radiation, types, Detection of Radiation, GM counter, Ionization chambers, Photographic detection , Scintillation Counter, Neutron detection

Text Books

J.P.Holman,Experimental Methods for Engineers, TMH , 7th Edition, 2007

Reference Book

E.O. Doebelin ,Measurement Systems; Application & Design, 6th Edition, 2011

Course Outcomes

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

- Measure calibration errors in instruments
- Measure Area of a given curve
- Choose the graph format for any given curve: Can draw Semi-Log Graph.
- Operate and understanding the operation of pressure, flow, temperature, strain & stress measuring instruments

Course No: **MECAO312**	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: **MECAO 311**	Course Title: **NUMERICAL METHODS**	**L**	**P**	**U**
		1	**6**	**4**

Course Learning Objectives: Enables one to devise algorithms for the numerical solutions of mathematical problems. Applications to problems from Engineering are included for each method.

Course Content:

UNIT 1:

Computer Arithmetic and Errors, Interval halving /Bisection , Linear interpolation methods, Newton's method, Muller's method, Fixed point iteration: x = g(x) method, Multiple roots.

UNIT II:

The Gaussian Elimination and Gauss - Jordan methods, LU-decomposition approach, Norms, Condition numbers and errors in solutions, Iterative methods-Gauss-Seidel and Jacobi methods

Unit-III:

Interpolation; Newton and Lagrangian polynomials, divided differences, Derivatives from difference tables, Higher order derivatives, Newton - Cotes integration formulas,
The trapezoidal rule - a composite.

UNIT IV:

Simpson's rules , Gaussian integration, The Taylor Series method, Euler and Modified Euler's method, Runge- Kutta methods, Multistep methods, Milne's method, The Adams-Moulton method, System of equations and higher order equations

UNIT V:

Solution through set of equations, Derivative boundary conditions, Eigen - value problems(Power Method)

Text Books

1. Steven Chapra, Raymond Canale., *Numerical Methods for Engineers*, Tata McGraw Hill, New Delhi, 5th Edition, 2007.

Reference Books

1. Francis Scheid , *Numerical Analysis*, Schaum's Outline, Tata McGraw Hill, New Delhi, 2009.

2. S.S.Sastry , *Numerical Methods* , PHI, New Delhi, 2010.

3. Erwin Kreyszig, *Advanced Engineering Mathematics*, 9th Edition, John Wiley & Sons, Inc, Singapore, 2006.

Learning Outcomes Upon successful completion of the course the student will be able to

- To solve nonlinear equations by standard methods.
- To solve Linear equations by Gauss-Seidel and other methods.
- To perform Matrix inversion by Gauss-Jordan method.
- To do Numerical differentiation and integration by standard methods.
- To solve ODEs numerically by standard methods.
- To apply software packages to solve above problems.

Course No	Course Title	L	P	U
MECHS 311	Dynamics of Social Change	3	0	3

Learning Objectives

The objective of this course is to enable students to have an insight into the social processes, sociological thought, methodology, sociological concepts and recent trends in modernization so as to empower the students to become active citizens. Sociological study aids in comprehending one's identity, thinking and action, it makes one more tolerant of human differences.

Course Contents:

Unit I

Sociology: its fundamentals, development of its methods and theories; Sociology and its relationship with other social sciences. Society: concepts and theories. Socialization and its theories, Social groups: Crowd Community, Association, Institutions.

Unit II

Family & Marriage: concepts, theories of origin; types, functions and changing patterns. Demographic transition.

Culture and its determinants: Social norms, Folkways, Mores, Taboos, Social roles, Social responsibility. Culture and personality.

Unit III

Social stratification: Caste, class, their functions and changing patterns.

Social Change: Concepts, Theories and Process and Dynamics of social change, Factors, Resistance to social change.

Unit IV

Modernization Concept: Industry and social change, Urbanization and rural sociology.

The role of education as a vital force for social change and to highlight the role of social institutions in educational and social developments.

Unit V

Sociology of Religion: Aspects, origin, Hinduism. Social disorganization and delinquency.

Text Book

Fundamentals of Sociology, Gisbert. P, Orient Longman, 3rd Edition, 1994.

Reference book(s)

1. Sociology - Systematic Introduction. Johnson.M.Harry. Allied Publishers, 2001
2. Sociology – A Guide to Problems and Literature. Bottomore T. T. Blackie & Sons, 1986.

Learning Outcomes:

After going through this course, the student will be able to:

- Define what social change is.
- Differentiate between social change and cultural change.
- Understand various characteristics of social change.
- Understand various sources of social change.
- Understand various factors of social change.
- Understand various theories of social change given by various sociologists.
- Understand the role of education for social change.

Course No: MECHS312	Course Title: Introduction to Psychology	L	P	U
		3	0	3

Learning Objectives

- To familiarize the students with type concepts of mind processes, motives, reactions, feelings, motivation
- To inculcate group thinking
- To develop skills like conflict resolution, crisis management

Course Content

UNIT I

Introduction: Definition of psychology; historical antecedents of psychology and trends in the 21st century; psychology and scientific methods; psychology in relation to other social sciences and natural sciences; application of psychology to societal problems.
Methods of psychology: Types of research, descriptive, evaluative, diagnostic and prognostic; methods of research: survey, observation, case-study and experiments; characteristics of experimental design and non-experimental design, quasi-experimental designs; focussed group discussions, brain storming, grounded theory approach.

UNIT II

Development of Human Behaviour: Growth and development; principles of development, role of genetic and environmental factors in determining human behaviour; influence of cultural factors in socialization; life span development, characteristics, development tasks, promoting psychological well-being across major stages of the life span.
Sensation, attention and perception: Sensation; concepts of threshold, absolute and difference thresholds, signal-detection and vigilance; factors influencing attention including set and characteristics of stimulus; definition and concept of perception, biological factors in perception; perceptual organization-influence of past experiences, perceptual defence-factors influencing space and depth perception, size estimation and perceptual readiness; the plasticity of perception; extrasensory perception; culture and perception, subliminal perception.

UNIT III

Learning: Concept and theories of learning (behaviourists, gestaltalist and information processing models); the processes of extinction, discrimination and generalization; programmed learning, probability learning, self-instructional learning, concepts; types and the schedules of reinforcement, escape, avoidance and punishment, modeling and social learning.
Memory: Encoding and remembering; short term memory, long term memory, sensory memory, iconic memory, echoic memory: the multistore model, levels of processing; organization and mnemonic techniques to improve memory; theories of forgetting: decay, interference and retrieval failure: metamemory; amnesia: anterograde and retrograde.
Motivation and emotion: Psychological and physiological basis of motivation and emotion; measurement of motivation and emotion; effects of motivation and emotion on behaviour; extrinsic and intrinsic motivation; factors influencing intrinsic motivation; emotional competence and the related issues.

UNIT IV

Thinking, problem solving: Piaget's theory of cognitive development; concept formation processes; information processing, reasoning and problem solving, facilitating and hindering factors in problem solving, methods of problem solving: creative thinking and fostering creativity; factors influencing decision making and judgment; recent trends.
Intelligence and aptitude: Concept of intelligence and aptitude, nature and theories of intelligence - Spearman, Thurstone, Gullford Vernon, Sternberg and J.P; Das; emotional intelligence, social intelligence, measurement of intelligence and aptitudes, concept of IQ, deviation IQ, constancy of IQ; measurement of multiple intelligence; fluid intelligence and crystallized intelligence.

UNIT V

Personality: Definition and concept of personality; theories of personality (psychoanalytical, sociocultural, interpersonal, developmental, humanistic, behaviouristic, trait and type approaches); Measurement of personality (projective tests, pencil-paper test); The Indian approach to personality; training for personality development; latest approaches like big 5 factor theory; the notion of self in different traditions.
Work Psychology and Organisational Behaviour: Personnel selection and training; use of psychological tests in the industry; training and human resource development; theories of work motivation, Herzberg, Maslow, Adam Equity theory, Porter and Lawler, Vroom; Leadership and participatory management; advertising and marketing; stress and its management; ergonomics; consumer psychology; managerial effectiveness; transformational leadership; sensitivity training; power and politics in organizations.

Text Books

1. Passer, M.W. and Smith, R.E. (2010). *Psychology: The science of mind and behavior*. 4th edn. Boston, MA, USA: McGraw-Hill Higher Education.
2. Pareek, U. and Khanna, S. (2012). *Understanding organizational behaviour*. 3rd edn. New Delhi, India: Oxford University Press.

Reference Books

1. Luthans, F. (2010). *Organizational behavior: An evidence-based approach*. 12th edn. New York, NY, USA: McGraw Hill Higher Education.
2. Morris, C.G. and Maisto, A.A. (2004). *Psychology: An introduction*. 12th edn. Harlow, United Kingdom: Prentice Hall.

Learning Outcomes

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

- Use critical thinking to evaluate and interpret evidence, and to apply psychological concepts, theories, and research findings to individual, social, and cultural issues
- Apply basic research methods in psychology, with sensitivity to ethical principles
- Demonstrate effective communication skills following professional conventions in psychology appropriate to purpose and context
- Understand the complexity of sociocultural diversity and societal inequality in the inquiry and analysis of psychological issues

Course No	Course Title	L	P	U
MECHS313	Heritage of India	3	0	3

Learning Objectives

Comprehending the heritage of the nation is a necessary pre condition for the making of conscientious citizenship. Knowledge of the nation's evolution and legacy enables to precisely define one's national self. Hence, this course is designed to serve the objective of enabling the students to take stock of the heritage and cultural evolution of their nation and its syncretic history.

Course Contents:

UNIT I: Indian Culture: An Introduction

Characteristics of Indian culture, Significance of Geography on Indian Culture. Society in India through ages- Ancient period- varna and jati, family and marriage in india, position of women in ancient india, Contemporary period; caste system and communalism. Religion and Philosophy in India: Ancient Period: Pre-Vedic and Vedic Religion, Buddhism and Jainism, Indian philosophy – Vedanta and Mimansa school of Philosophy.

UNIT II: Indian Languages and Literature

Evolution of script and languages in India: Harappan Script and Brahmi Script. Short History of the Sanskrit literature: The Vedas, The Brahmanas and Upanishads & Sutras, Epics: Ramayana and Mahabharata & Puranas. History of Buddhist and Jain Literature in Pali, Prakrit and Sanskrit, Sangama literature & Odia literature.

UNIT III: A Brief History of Indian Arts and Architecture

Indian Art & Architecture: Gandhara School and Mathura School of Art; Hindu Temple Architecture, Buddhist Architecture, Medieval Architecture and Colonial Architecture. Indian Painting Tradition: ancient, medieval, modern indian painting and odishan painting tradition. Performing Arts: Divisions of Indian classical music: Hindustani and Carnatic, Dances of India: Various Dance forms: Classical and Regional, Rise of modern theatre and Indian cinema.

UNIT IV: Spread of Indian Culture Abroad

Causes, Significance and Modes of Cultural Exchange - Through Traders, Teachers, Emissaries, Missionaries and Gypsies, Indian Culture in South East Asia, India, Central Asia and Western World through ages.

.

UNIT V: Understand and appreciate the heritage of India in various fields of applied sciences

Applied Sciences: Geography, Astronomy, Mathematics, Physics, Chemistry, Physiology, Medicine, Coinage, Weights and Measures, India's contribution to the world civilizations and the external influences on Indian Heritage

Text Books

Basham, A.L, The Wonder That was India, Picador, London, 2004.

Reference Books

1. Nehru, Jawaharlal, the Discovery of India, Jawaharlal Memorial Fund, New Delhi, 1999.
2. Thapar, Romila, The History of India, Vol. I, Penguin, New Delhi, 1966
3. Basham, A.L, ed., A Cultural History of India, Penguin, New Delhi, 1988.
4. Jha, D.N, Ancient Indian in Historical Outline, Manohar, New Delhi, 2004.
5. Wolpert, Stanley, an Introduction to India, Penguin, New Delhi, 1994.
6. Mazumdar, R.C, et.al, an Advanced History of India, MUP, Michigan, 1969.
7. Malekandathil, Pius: Maritime India: Trade, Religion and Polity in the Indian Ocean, Primus Books, Delhi, 2010.
8. McPherson, Kenneth: The early Maritime Trade of the Indian Ocean, in: ib.: The Indian Ocean: A History of People and The Sea, OUP, 1993, pp. 16-75.
9. Christie, J.W., 1995, State formation In early Maritime Southeast Asia, BTLV

Course No	Course Title	L	P	U
MECHS314	Modern Political Science	3	0	3

Objectives

- To familiarise the students with the basic ideas of political science.
- To make them thorough in the concepts of political theory.
- To help them understand and distinguish between basic concepts like political theory, political thought and political philosophy.
- To help the students understand and relate the concepts and facts with the political realities of the country and different parts of the world.
- To equip them with the basics of the discipline and help them learn the basic underpinnings of the subject of Political Science.

Unit I Political Theory
Nature, scope and significance of political theory, procedure of different theoretical ideas in political theory, the various traditional and modern theories of political science., theories of origin of the state.

Unit II Political Theory

Concept of Democracy, its types and theories (Elitist, Pluralist and Marxist) relating to it, concept of Development and various views and Perspective relating to it. i.e. Liberal, Marxist, Sustainable Development, Human Development and Gandhian Model of Development, Understanding basic concepts of Justice, distributive justice, multiculturalism and social justice.

Unit III Politics in India

Philosophy of Indian constitutions, introducing the Indian Constitution with a focus on the evolution of it and examining the essence of the Preamble, e Fundamental Rights and Duties of Indian citizens with a study of the significance and status of Directive Principles.
Analyzing the important institutions of the Indian Union: the Executive: President; Prime Minister, Council of Ministers; Governor, Chief Minister and Council of Ministers; The legislature: Rajya Sabha, Lok Sabha, Speaker, Committee System, State Legislature, The Judiciary: Supreme Court and the High Court: composition and functions- Judicial Activism

Unit IV Politics in India
Centre-State Relations with focus on the Legislative, Administrative and Financial Relations., evaluating the Indian Party system – its development and looking at the ideology of dominant national parties, the Electoral Process in India with focus on the Election Commission: Composition, Functions and Role, the challenges to National Integration: Terrorism, Regionalism and Casteism.

Unit V International Relations
Overview about the nature, evolution and scope of international relations, the basic ideas of international relations, the different approaches to the study of International Relations,historical background of the discipline which will help them understand international politics in a better way, basic concepts of International Relations and also develop a preliminary understanding of the global economy, formation, charter and objectives of United Nations and its working on Millennium Development Goals, the working of United Nations in resolving conflict and peacekeeping operations, the international security; Disarmament, Arms Control and Nuclear nonproliferation

Text Books:

1. J.C. Johari – "Principles of Modern Political Science", Sterling Publishers PVT. Ltd., New Delhi, 2007
2. Perter Harris, "Foundations of Political Science", Oxford University Press

References:

1. Amal Ray and Mohit Bhattacharya – "Political Theory: Institutions and Ideas" - The World Press Private Ltd., Calcutta, 1988
2. O.P. Gauba – "An Introduction to Political theory" Macmillan India Ltd., 2008.
3. Robert Dahl – "Modern political Analysis." OUP 2007
4. Prof. A.C Kapoor - "Principles of Political Science", Sterling Publishers PVT. Ltd., New Delhi, 2005

Course Outcomes:

- Understanding of government institutions, electoral processes, and policies in a variety of countries around the world and the ability to compare the effectiveness or impact of various political arrangements across countries.
- Knowledge of some of the philosophical underpinnings of modern politics and government and the legal principles by which political disputes are often settled.
- Understand the changes in patterns of political behaviour, ideas and structures.
- Assess how global, national and regional developments affect polity and society.
- Develop the ability to make logical inferences about social and political issues on the basis of comparative and historical knowledge.
- Knowledge of key theories and concepts, historical developments, organizations, and modern issues in international relations.

Course No	Course Title	L	P	U
MECHS315	Public Administration	3	0	3

Learning Objectives

The course on Public Administration/Management has following objectives:

1. Understand the concept of public administration/ management/organization
2. Understand the evolution of the concept of public administration and its importance
3. Understand the role of government
4. Understand the role and core functions of public manager
5. Understand the structure of government /organizations
6. Create understanding about the skills required by the public manager in imparting duties
7. Understand the changing role of government and role of public managers.

Course Contents:

Unit I

Introduction:

Meaning, scope, and significance of Public Administration, Wilson's vision of Public Administration, Evolution of the discipline and its present status, New Public Administration, Public Choice approach, Challenges of liberalization, Privatisation, Globalisation, Good Governance: concept and application, New Public Management

Unit II

Administrative Thought, Scientific Management and Scientific Management movement, Classical Theory, Weber's bureaucratic model – its critique and post-Weberian Developments, Dynamic Administration, Human Relations School, Functions of the Executive, Simon's decision-making theory, Participative Management.

Unit III

Administrative Behaviour, Process and techniques of decision-making , Communication; Morale Motivation Theories – content, process and contemporary, Theories of Leadership: Traditional and Modern

Organisations - Theories – systems, contingency, Structure and forms:ministries & departments, corporations, companies, boards, commissions, ad hoc and advisory bodies, headquarters and field relationships, regulatory authorities, public-private partnerships.

Unit IV

Accountability and control - Concepts of accountability and control; Citizen and Administration, Legislative, Executive and Judicial control over administration, Role of media, interest groups & voluntary organizations, Civil society, Citizen's Charters, Right to Information, Social audit.

Unit V

Administrative Law - Meaning, scope, and significance, Dicey on Administrative law, Delegated legislation, Administrative Tribunals.

Comparative Public Administration - Historical and sociological factors affecting administrative systems, Administration and politics in different countries, Current status of Comparative Public Administration, Ecology and administration, Riggsian models and their critique,

Techniques of Administrative Improvement - Organisation and methods, Work-study and work management, Management aid tools like network analysis, MIS, PERT, CPM, e-governance and information technology.

Text Book:

1. Baker, R.J.S., 1972, Administrative Theory and Public Administration, Hutchinson University Library, London.
2. Bhattacharya, Mohit, 1998, New Horizons of Public Administration, Jawahar Publishers & Distributors, New Delhi.

References:

1. Bertram, M. Gross, 1964, The Managing of Organisations, The Administrative Struggle, The Free Press of Glencoe, CollierMacmillan., London.
2. Denhardt, Robert B. and Joseph W. Grubbs, 2003, Public Administration: An action Orientation, Fourth Edition, Thomson (Wadsworth), Canada.
3. Prasad, D. Ravindra, V.S. Prasad and P. Satyanarayan, 2004, Administrative Thinkers (Ed), Sterling Publishers, New Delhi.
4. Pugh, D.S., 1985, Organisation Theory: Selected Readings (Ed), Penguin Books, Middlesex, England.
5. Sharma, M.P. and B.L. Sardana, 1988, Public Administration in Theory and Practice, Kitab Mahal, New Delhi.
6. Srivastava, Om Prie, 1991, Public Administration and Management, The Broadening Horizons, Volume 1, Himalaya Publishing House, Delhi

COURSE OUTCOMES:

- To understand the nature and scope of Public Administration;
- To appreciate the methodological pluralism and synthesizing nature of knowledge in Public Administration;
- To comprehend the changing paradigms of Public Administration;
- To acquaint with the theories, approaches, concepts and principles of Public Administration;
- To understand the administrative theories and concepts to make sense of administrative practices.
- To Understand public administration theory and concepts from multiple perspectives

Course No: MECHS316	Course Title: Professional Ethics	L	P	U
		3	0	3

Learning Objectives

- To create an awareness on Ethics as applied in Engineering and Human Values
- Understand what morality is and how it connects to professional ethics
- Determine what characterizes a professional and distinguishes one from a nonprofessional

Course Content

UNIT I

Morals, values and ethics, integrity, work ethic, service learning, civic virtue, respect for others, living peacefully, caring, sharing, honesty, courage, valuing time, co-operation, commitment, empathy, self-confidence, character, spirituality.

UNIT II

Senses of 'Engineering Ethics', variety of moral issued, types of inquiry, moral dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, consensus and controversy, models of professional roles, theories about right action, self-interest, customs and religion, uses of ethical theories.

UNIT III

Engineering as experimentation, engineers as responsible experimenters, codes of ethics, a balanced outlook on law, the challenger case study.

UNIT IV

Safety and risk, assessment of safety and risk, risk benefit analysis and reducing risk, the Three Mile Island and Chernobyl case studies. Collegiality and loyalty, respect for authority, collective bargaining, confidentiality, conflicts of interest, occupational crime, professional rights, employee rights, Intellectual Property Rights (IPR), discrimination.

UNIT V

Multinational corporations, environmental ethics, computer ethics, weapons development, engineers as managers, consulting engineers, engineers as expert witnesses and advisors, moral leadership, sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers(India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers(IETE), India, etc.

S. Vijayalakshmi

REGISTRAR
THE ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deemed-to-be-University Under Section 3 of the UGC Act, 1956)

Text Books

1. Martin, M.W. and Schinzinger, R. (2004). *Ethics in engineering*. 4th edn. Boston, MA, USA: McGraw Hill Higher Education.
2. Govindarajan, M., Natarajan, S. and Senthilkumar, V.S. (2004). *Engineering ethics*. New Delhi, India: Prentice-Hall of India Pvt.

Reference Books

1. Fleddermann, C.B. (2011). *Engineering ethics*. 4th edn. Boston, MA, USA: Prentice Hall.
2. Harris, J.C.E., Rabins, M.J., Pritchard, M.S., James, R. and Englehardt, E. (2013). *Engineering ethics: Concepts and cases*. 5th edn. Boston, MA, USA: Wadsworth Cengage Learning.
3. Boatright, J.R. (2011). *Ethics and the conduct of business*. Boston, MA, USA: Pearson College Div.
4. Seebauer, E.G. and Barry, R.L. (2010). *Fundamentals of ethics for scientists and engineers*. New York, NY, USA: Oxford University Press.

Learning Outcomes

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

- Choose their own personal, social, moral and spiritual values and be aware of practical methods for developing and deepening
- Assess their own ethical values and the social context of problems
- Identify an ethical issue and analyze that issue in relationship to the specific topic of study or discipline

Course No	Course Title	L	P	U
IP221	Internship Program I	0	0	5

Scope & Objective of the Course:

This course is run during the Summer Term only at various industries and is of about 8 weeks. This course aims to provide an exposure of the world of professional work to the students.

Textbook(s): Not Applicable
Reference book(s): Not Applicable
Lecture-wise plan: Not Applicable

Evaluation Scheme:

Evaluation Component	Weightage (%)	Duration
Quiz-I	5	2nd week
Group Discussion-I	7	3rd week
Seminar-I	10	6th week
Project Report-I	10	7th week
Observation-I	6	7th week
Diary-I	2	Daily
Mid-Term Grading	40	16th week
Quiz-II	5	9th week
Group Discussion-II	8	12th week
Seminar-II	15	15th week
Project Report-II	20	16th week
Observation-II	9	16th week
Diary-II	3	Daily
Final Grading	100	

Course No	Course Title	L	P	U
IP401	Internship Program II	0	0	20

Scope & Objective of the Course:

The IP II Program is planned to bridge the gap between the professional world and the academic world and is implemented during the final year of graduation in either of the semesters. This Program constitutes working on real life situations, necessary for subsequent problem-solving efforts in the professional world.

Textbook(s): Not Applicable
Reference book(s): Not Applicable
Lecture-wise plan: Not Applicable

Evaluation Scheme:

Evaluation Component	Weightage (%)	Duration
Quiz-I	4	2nd week
Group Discussion-I	5	3rd week
Seminar-I	6	6th week
Project Report-I	5	7th week
Observation-I	3	7th week
Diary-I	3	Daily
Quiz-II	4	9th week
Group Discussion-II	5	12th week
Seminar-II	6	15th week
Project Report-II	5	16th week
Observation-II	3	16th week
Diary-II	3	Daily
Mid-Term Grading	52	16th week
Quiz-III	4	17th week
Group Discussion-III	5	20th week
Seminar-III	12	Last week of IP II
Project Report-III	20	22nd week
Observation-III	4	End of IP II
Diary-III	3	Daily
Final Grading	100	

Course No	Course Title	L	P	U
TS401	Thesis & Seminar	0	0	20

Objective of the course:
This course TS 401 is a must for all students with Thesis option for the eligibility of degree. This course involves research work in an active area to satisfy the creative urge in a student and may involve advanced study learning and experimentation. This work may form the basis for dissertation of a higher degree. Also this requires fulltime work from the student for a complete semester and must co-terminate with thesis report.

Textbook(s) No prescribed text book. Literature Survey to be done with peer reviewed journals.
Reference book(s) - do -
Mid -Semester Grading and Final Grading
TS 401 courses are only awarded non-letter grades Excellent/Good/Fair/ Poor based on the performance of the student as per the evaluation scheme Mid term Grading is to be done announced to the student. All grades are to be submitted to the IC in the format provided to the Supervisors.
Operation Procedure
1. Student has to devote full semester for TS 401 course.
2. Student has to report to Supervisor regularly.
3. Particular of Thesis is to be submitted to IC within two weeks of registration
4. Seminars and Thesis evaluation has to carried out in the presence of two member Committee comprising of experts in the relevant area constituted by the Supervisor.
5. Final Thesis to be submitted has to be in formal hard bound cover bearing the Institute emblem.

Course No	Course Title	L	P	U
CE 491/CS 491 EC 491/EE 491 ME 491	Special Project	0	0	3

- **Scope & objective of the course:**

This is an unstructured open ended where under the overall supervision of a faculty-in-charge, batches of students will be attached to different faculty members. 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. Faculty-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 faculty member and faculty-in-charge. The faculty-in-charge may assign specific hours of formal brain storming sessions.

4. Evaluation Scheme:

Component	Duration (hr/min)	Weightage (%)	Remarks
Literature Survey	2nd week	7	
Project outline	3rd week	5	**To be submitted to I/C by the faculty**
Diary -I	**Continuous**	4	
Observation-I	**Continuous**	4	
MidTerm Project	7th week	15	
Report	7th week		
Mid-Semester	8th week	10	
Seminar/Viva	8th week		
Mid-Term Grading	8th week	45	**To be submitted to I/C by the faculty**
Diary-II	**Continuous**	5	
Observation-II	**Continuous**	5	**A copy to be submitted to I/C by the faculty**
Final Project Report	14th week	25	
Final Seminar	15th week	20	
Final Grading	15th week	100	**To be submitted to I/C by the faculty**

Textbook(s) & Reference book(s)

Based on literature survey to be done with peer reviewed journals.

General guidelines:

a) This being a three unit course, a student is expected to work for at least 9 hours per week including the formal contact hours with the instructor.

b) Each student should meet the faculty at least once a week in addition to the formal contact hours at mutually agreed time to apprise the faculty of the progress in the project.

c) Student is supposed to maintain a diary and record the daily progress of the work done. The diary would be periodically checked by the faculty.

d) All the evaluation components are compulsory. If a student misses any component of evaluation, he is likely to get 'NC'.

e) The Mid-term evaluation is to be strict to avoid any laxity on the part of the student.

f) Student should make two copies of the final report in the prescribed format, one his personal copy and the other for submission to the Institute. The faculty may ask for an additional copy if so desired.

g) The final seminar is to be planned only after the submission of the project report.

h) The final seminar is open to all the students and the faculty. The faculty member should involve the local experts in the evaluation of final seminar.

i) If the progress in the project work is not satisfactory, the faculty may advise the student to withdraw from the course in time and the same may be communicated to the instructor-in-charge.

j) The student should submit the withdrawal request to the Convener, Academic Registration Committee. The last day for withdrawal is the same as that for all other courses.

k) If more than one student is working on the same project, the distribution of work among the students is to be made clear to the students and the Instructor-in-charge. The evaluation should be based on individual performances only.

l) The details of components of evaluation should be submitted in the prescribed format only.

m) The student is expected to attend a **conference** on the area of project opted or present a **technical paper** in any of the journal.

Course No	Course Title	L	P	U
TIP 491	Technology Innovation Project	0	0	3

Scope & Objective of the course:

A unique opportunity for the students in the form of a course that facilitate the combination of academics with the industry by involving an in-depth innovation, investigation under the supervision of mentor from Industry and a faculty member for performing the real-life projects with the support from various organizations. Students working in groups will be required to perform research, customer and problem discovery, ideation, concept creation and validation, and technical implementation for a real-world challenge. The specific time-bound based on the students registered for the course will be graded based on the performance feedback from both the industry and the Faculty supervisor. The student will be able to improve the skills and knowledge for improving written and oral communication with indicative content which includes innovation methodology, customer & problem discovery, problem validation, innovation experiments with innovative presentations.

Evaluation:
Student evaluation is based on Literature survey, seminar series conducted, and observations of the supervisor and Thesis report.

Component	Weightage (%)	Date	Remarks
Literature Survey and Project outline	20	3rd week	Supervisor to submit copy to IC
Mid-term Project Report	10	7th week	Supervisor to submit to IC after evaluation
Mid-term Seminar	20	8th Week	Mid-semester grading to be submitted to IC by Supervisor
End-Sem Project Report	25	14th week	Supervisor to submit to IC after evaluation
End-Sem Seminar	25	15th Week	

Textbook T1	There are no specifically prescribed or recommended texts for this subject as student must do literature survey from journals of his field of research.
Reference book(s) R1	Related to Project work

General Guidelines:

a) This being a three-unit course, a student is expected to work for at least 12- 14 hours per week including the formal contact hours with the instructor.

b) Each student should meet the faculty and mentor from Industry at least twice a week in addition to the formal contact hours at mutually agreed time to apprise the faculty of the progress in the project.

c) Student is supposed to maintain a diary and record the daily progress of the work done. The diary would be periodically checked by the faculty.

d) All the evaluation components are compulsory. If a student misses any component of evaluation, he is likely to get "NC".

e) The Mid-term evaluation is to be strict to avoid any laxity on the part of the student.

f) Student should make two copies of the final report in the prescribed format, one his personal copy and the other for submission to eh Institute. The faculty may ask for an additional copy if so desired.

g) The final seminar is to be planned only after the submission of the project report.

h) The final seminar is open to all the student and the faculty. The faculty member should involve the local experts in the evaluation of final seminar.

i) If the progress in the project work is not satisfactory, the faculty may advise the student to withdraw from the course in time and the same may be communicated to the instructor-in-charge.

j) The student should submit the withdrawal request to the Convener, Academic Registration Committee. The last day for withdrawal is the same as that for all other courses.

k) If more than one student is working on the same project, the distribution of work among the students is to be made clear to the students and the Instructor-in-charge. The evaluation should be based on individual performances only.

l) The details of components of evaluation should be submitted in the prescribed format only.

m) The student is expected to attend a conference on the area of project opted or present a **technical paper** in any of the journal.

Learning Outcomes:

After successful completion of the course student will be able to

1. Work independently as part of an interdisciplinary team to complete a technical innovation project
2. Collect and critically analyse a range of data about the project allotted by creating innovation hypotheses from the data
3. Validate innovation hypotheses
4. Conceptualize, design, and implement an innovative and technology-based solution to the identified problem Present technical solutions to various stakeholders in both written and oral forms

B.Tech Mechatronics Program (MEC)
Course Handouts

Course No: MEC 221	Course Title: Elements of Mechatronics	L	P	U
		3	0	3

Learning Objective: This course is designed for students to

(1) understand the concept of mechatronics,
(2) learn design principles to integrate multidisciplinary components as a system to meet requirements of products,
(3) gain the fundamental knowledge about robots and automation,
(4) have hand-on skills in developing basic mechatronic products.

Course Contents

UNIT -I

Introduction and Definition of Mechatronics, need and emerging areas, classification, system terminology, Mechatronics in manufacturing, electronics, automation and other potential area.

UNIT-II

Elements of Mechatronic systems: Resistive elements and networks; independent and dependent sources; switches and MOS transistors; digital abstraction; amplifiers; energy storage elements; data conversion devices, sensors, transducers, signal processing devices, relays, signal conversions, conditioning and Integrated circuits.

UNIT-III

Mechanical activating systems and devices - Drives and mechanisms of an automated system, stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms

UNIT-IV

Microprocessor, Microcontroller, applications, classification, organization nd programming, instructional set and central processing unit,

UNIT-V

Mechatronics Design process, Traditional and Mechatronics designs, Model based system design, modeling of system, block diagram, simulation, hardware in loop simulation, Optimization. Case studies on mechatronic system in household appliances.

Text:

1. "Mechatronics – Electronic control systems in Mechanical and Electrical Engineering" William Bolton, Pearson, 6th Edition, 2015.

References:

(1) "Fundamentals of Mechatronics," Musa Jouaneh, Cengage Learning, 2011.
(2) "Mechatronics," Sabri Cetinkunt, Wiley, 2006.
(3) "Mechatronics: a Foundation Course", Clarence de Silva, CRC Press, 2010.
(4) "Mechatronics Systems Fundamentals", Rolf Isermann, Springer, 2005.

Course Outcomes:

(1) A student who successfully fulfills the course requirements will have demonstrated
(2) An ability to identify, select, and integrate mechatronic components to meet product requirements
(3) An ability to develop kinematic, dynamic and control models for robots
(4) An ability to use commercial software tools for modeling and simulation of mechatronic systems
(5) An ability to design, analyze, and optimize mechatronic products
(6) An ability to write technical reports and present engineering design solutions efficiently

Course No: MEC 222	Course Title: Kinematics & Dynamics of Machines	L	P	U
		3	0	3

Learning Objectives

- To understand the fundamentals of kinematics and dynamics of machinery
- To develop competency in drawing velocity and acceleration diagram for simple and complex mechanism
- To have given motions, able to analyze forces in machines
- To understand the relative motion analysis and design of gears, gear trains, cams, cams and linkages
- To design and prototype a mehanisam

UNIT-I

Kinematics and Dynamics, Mechanisms and Machines, Plane and Space Mechanisms, Kinematic Pairs, links and joints, Kinematic Chains, Degree of Freedom, Kinematic Inversion, Four bar mechanisms and its inversions, Mobility and range of movement, Kutzbach and Grubler's criterion, Grashof's criterion.

UNIT-II

Displacement, Velocity and Acceleration analysis of plane mechanisms– graphical and analytical methods, Instantaneous Centre of Velocity, Velocity and acceleration images, corrolies component of acceleration, special mechanisms – strighline, indicator and steering mechanisms

UNIT-III

Cams – classification of cams and followers, nomenclature, description and analysis of follower motion, Gears – terminology, types, fundamental law of gearing, involute profile, Interference and undercutting, minimum number of teeth, gear trains- – simple , compound and epicyclic gear trains

UNIT-IV

Dynamic Analysis:Applied and constraint forces-static equilibrium conditions-two, three force members, equations of motion, dynamic force analysis, inertia force and inertia torque, D'Alemberts principle, principle of superposition. Balancing:Static and dynamic balancing, balancing of rotating masses, balancing of reciprocating masses, balancing linkages.

UNIT- V

Control Mechanisms:Governors, types, centrifugal governors, gravity controlled and spring controlled centrifugal governors characteristics – stability- sensitiveness-hunting, isochronisms. Gyroscopes, gyroscopic forces and torques, gyroscopic stabilization, gyroscopic effects in automobiles, ships and airplanes

Text Books:

2. S.S.Rattan, Theory of Machines, 4th Edition, 2017, Tata Mc Graw Hill

Reference Books:

1. R.L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill Publishing Company Ltd, New Delhi
2. J J Uicker et al, Theory of Machines and Mechanisms (India Edition) Oxford University Press
3. J S Rao and R V Dukipatti, Mechanism and Machine Theory, New Age International.
4. Amitabha Ghosh and Asok Kumar Mallik, Theory of Mechanisms & Machines East-West Press Pvt Ltd

Course Outcomes

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

1. Identifying mechanisms in real life applications
2. Perform static and dynamic analysis of mechanims
3. Buid the team spirt by working in group and able to produce a mechanism for specific task.

Course No: MEC311	Course Title: Introduction to Robotics	L	P	U
		3	0	3

Learning Objectives

- To develop knowledge in various robot structures and their work space.
- To perform kinematic analysis of robot systems.
- To perform dynamics analysis of robot systems.
- To provide knowledge and analysis skills associated with trajectory planning and robot control.

Course Contents

UNIT-I

Introduction, Brief History, Classification, Components, Degrees of freedom, Characteristics, Co-ordinates, Reference frames, Robot Configurations and Concept of Workspace, Mechanisms and Transmission, End effectors and Grippers.

UNIT-II

Position and orientation of a rigid body, Coordinate transformations, Euler angles, Homogeneous transformation. Link representation using Denavit-Hartenberg parameters, Examples of D-H parameters and link transformation

UNIT-III

Kinematic equations, Direct and Inverse kinematics of serial manipulators, examples, constrained and redundant robot, Direct and Inverse kinematics of parallel manipulators, Differential motion : Differential relationships, Jacobian, Singularity and Redundancy.

UNIT-IV

Static Force Analysis of Robots : Force and Moment Analysis, Transformation of Forces and Moments between coordinate frames, Stiffness. Dynamic Analysis : Newton-Euler Formulation of Equations of motion, Lagrangian Formulation of Manipulator Dynamics, Inverse Dynamics.

UNIT-V

Basics of trajectory planning, General considerations, Joint interpolated trajectories, Cartesian path trajectories, Executing user specified tasks. Independent joint control, PD and PID feedback, Actuator models, Computed torque control, Force control, Hybrid control.

S. Vijayalakshmi

Text Books:

1. Ashitava Goshal, Robotics : Fundamental concepts and Analysis, Oxford university press, 2010.
2. H. Asada and J.J. Slotine , Robot Analysis and Control , John-Wiley and Sons

Reference Books:

3. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.
4. Saeed B. Niku , Introduction to Robotics : Analysis, Systems, Applications, Pearson Education.
5. K. S. Fu, R. C. Gonzalez and C.S.G. Lee, ROBOTICS: Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
6. J. J. Craig, Introduction to Robotics : Mechanics and Control, Pearson Printice hall, 4th Edition, 2017.

Course Outcomes

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

- Demonstrate the relationship between mechanical structures of industrial robots and their operational workspace characteristics.
- Apply spatial transformation to obtain kinematic equations of robot manipulators so that forward and inverse kinematics of simple robot manipulators can be performed.
- Perform the static force analysis and dynamic analysis of manipulator.
- Generate joint trajectory for motion planning.
- Demonstrate knowledge of robot controllers.

Course No	Course Title:	L	P	U
MEC312	Materials for Mechatronic Systems	3	0	3

Learning Objectives

- To understand properties and behavior of various types of materials.
- To acquire knowledge on materials used in mechanical systems.
- To gain knowledge on materials used in electronic systems and applications.
- To analyze testing methods of different materials
- To select materials for various applications

Course Contents

UNIT-I

Engineering materials-Types, structure and properties, Introduction to ferrous and non-ferrous metals. Ferrous metals- Iron and its alloys, classification, composition, properties and applications. Non-ferrous metals-Aluminum, copper, lead, magnesium, nickel properties and applications. Non-ferrous alloys- Alloys of aluminum, copper, magnesium, properties and applications.

UNIT-II

Non-metallic materials- Introduction and types. Ceramics-introduction, classification, properties, production techniques and applications. Refractories- properties, types and applications. Polymers- introduction, types, properties and applications. Composites-types, structure, properties, processing techniques and applications.

UNIT-III

Dielectric materials-Introduction, solid dielectrics, liquid dielectrics, electric conductivity in solid, liquid, and gaseous dielectrics. Ferromagnetic materials, anti-ferromagnetic materials, piezoelectric materials and pyroelectric materials. Magnetic materials, semiconductor materials.

UNIT-IV

Special purpose materials- Refractory materials, structural materials, Radioactive materials, Galvanization and Impregnation materials, processing of electronic materials, insulating varnishes and coolants, properties and applications of mineral oils

UNIT- V

Material failure and testing-types of fracture and principles of fracture mechanism, fatigue, and creep. Mechanical testing and NDT. Eddy-current testing and acoustic emission inspection. Selection of materials for engineering applications.

Text Books:

1. Flinn R.A. and Trojan P.K., "Engineering Materials and their Applications", 4th edition, Jaico, 1999.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", 9th edition, prentice-Hall of India Private Limited, 2012.
3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006
4. Charles J.A., Crane F.A.A. and Fumess J.A.G., "Selection and use of engineering Materials", 3rd edition, Butterworth-Heiremann, 2001.

Reference Books:

7. Thomas H. Courtney, "Mechanical Behaviour of Materials", 2nd edition, McGraw Hill, 2000.
8. TTTI Madras, "Electrical Engineering Materials" McGraw Hill Education, 2004.
9. William D. Callister, "Material Science and Engineering", John Wiley and Sons, 2007.
10. Dieter G.E, "Mechanical Metallurgy", McGraw Hill, 1990.
11. Sydney H. Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 2007.

Course Outcomes

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

- Understand the characteristics of various engineering materials.
- Evaluate different materials used in mechanical and electronic systems.
- Select suitable materials for various mechatronic applications.

Course No: MEC 313	Course Title: Instrumentation and Measurements	L	P	U
		3	0	3

Learning Objectives

- To measure the energy and power for various applications.
- To analyze and design the measurement system of Motion, pressure, flow, temperature level, viscosity, pH, humidity, vibration etc.
- To develop skills required for designing and testing op-amps, instrumentation amplifier, bridges, carrier amplifier, chopper amplifier, charge amplifier and Isolation amplifier.
- To measure data from filters, Data acquisition system, inverse transducers & feedback measurement systems.
- To design the Counters for Grounding and Shielding techniques, Instrumentation in hazardous areas, Industrial data communication.

Course Contents

UNIT-I

Measurement Systems, Units, and Standards: Unit Systems, Scientific Notation and Fundamental Mechanical Units ,The SI Electrical Units, Absolute and secondary instruments, indicating instruments, control, balancing and damping, constructional details, characteristics, errors in measurement, Ammeters, voltmeters: (DC/AC) PMMC, MI, Electrodynamometer type.

UNIT-II

Electromechanical Ammeters, Voltmeters, and Ohmmeters: DC Ammeter, DC Voltmeter, Rectifier Voltmeter, Rectifier Ammeter, Series Ohmmeter, Shunt Ohmmeter, Ohmmeter Accuracy, Volt-Ohm-Milliammeter

UNIT-III

Analog Oscilloscopes: Cathode-ray Tube, Deflection Amplifier, Waveform Display, Oscilloscope Time Base, Dual-trace Oscilloscopes, Oscilloscope Controls, Measurement of Voltage, Frequency, and Phase Pulse Measurements, Oscilloscope Probes, Display of Device Characteristics, X-Y and Z Displays, Oscilloscope Specifications and Performance.

UNIT-IV

Electro-Mechanical Measurements: Instrumentation Amplifiers bridges, carrier amplifier, chopper amplifier, charge amplifier and Isolation amplifier, measurement of Motion, pressure,

flow, temperature level, viscosity, pH, humidity, vibration, Signal conducting techniques using op-amps

UNIT- V

Data Acquisition Systems: Introduction to Basic Components of Data Acquisition Systems, Components of a Typical PC-based Data Acquisition System, Analog Input Subsystem, Analog Output Subsystem, Digital Input and Output Subsystem, IEEE 488 Interface, Recording, Storage and Display Devices, Analog Recorders, Digital Recorders, Display System

Text Books:

1. Electronic Instrumentation and Measurements, by David. A. Bell Third edition, Oxford press, ISBN:9780195696141
2. Introduction to Instrumentation and Measurements by Robert .B. Northrop ,3rd Edition, Taylor & Francis, ISBN-10: 1466596775,ISBN-13: 978-1466596771

Reference Books:

1. Measurement Systems, application and design by E.O Doebelin and Dhanesh N. Manik, Tata McGraw- Hill
2. Electrical and Electronics Measurements and Instrumentation, by Prithwiraj Purkait and Biswas, Tata McGraw- Hill, 2013, ISBN (13): 978-1-25-902959-2,ISBN (10): 1-25-902959-X
3. Electronic Measurements and Instrumentation, by Bernard Oliver and John Cage,

Course Outcomes

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

- Design and analyze various measurement systems.
- Elucidate the data from data acquisition systems
- Illustrate the function and application of Electro mechanical instruments

REGISTRAR
THE ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deemed-to-be-University Under Section 3 of the UGC Act, 1956)

Course No: MEC 314	Course Title: Microprocessor and Controller	L	P	U
		3	2	4

Learning Objectives

1. To understand fundamental operating concepts of Microprocessor.
2. To learn about the Architecture, addressing modes & instruction set of 8086 & 8051.
3. To learn about the microprocessor interfacing and programming.
4. To communicate with various devices using controller.
5. To understand the commonly used peripheral / interfacing ICs.

Course Contents

UNIT I

Introduction to Microprocessor- Organization of 8085: Architecture, Internal Register Organization and Pin Configuration – Instruction Set of 8085 – addressing modes – instruction machine cycles with states and timing diagram- 8085 assembly language programming- Examples.

UNIT II

Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation, Operating Modes Instruction Set of 8086 Addressing Modes: Instruction format: Discussion on instruction Set: Groups: data transfer, arithmetic, logic string, branch control transfer, processor control. Interrupts: Hardware and software interrupts, responses and types.

UNIT III

Microprocessor Interfacing: Need for Interfacing - Memory Interfacing, address space partitioning – address map – Address decoding – Designing decoders circuit. I/O Interfacing: Data transfer schemes – programmed Synchronous and asynchronous – Interrupt driven Transfer – Multiple devices and multiple interrupt levels – enabling disabling and masking of interrupts. DMA transfer: Cycle stealing – Burst mode – Multiple DMA devices – DMA transfer in 8085 system – serial data transfer.

UNIT IV

Interfacing Devices: Programmable peripheral device (8255) – programmable interval timer (8353) – Programmable communication interface (8251) (USART) – Programmable interrupt controller – Programmable DMA Controller (8257)- Programmable Keyboard/display controllers.(8279)

UNIT V

Microcontroller: Introduction to Microcontroller and its families, Criteria for Choosing Microcontroller. Microcontroller Architecture, Programming model, Addressing modes, Instruction sets, Assembly and C programming for Microcontroller, I/O programming using assembly and C language, Interrupt Controller, I/O interfacing, Timers, Real Time Clock, Serial and parallel Communication protocols, SPI Controllers. LCD Controller. Microcontroller Interfacing: Introduction to Microcontroller Interfacing.

Text Books:

1. Ramesh S. Goankar , "Microprocessor – Architecture, Programming and Applications with the 8085" Penram International Publisher , 5th Edition, 2006
2. Yn-cheng Liu,Glenn A. Gibson, "Microcomputer systems: The 8086 / 8088 Family architecture,
   Programming and Design", 2 nd Edition, Prentice Hall of India , 2006 .

Reference Books:

1. Douglas V.Hall, "Microprocessors and Interfacing: Programming and Hardware", 2nd Edition , TMG Hill, 2006.
2. A.K.Ray & K.M Bhurchandi, "Advanced Microprocessor and Peripherals – Architecture,
   Programming and Interfacing", Tata Mc Graw Hill, 2006.
3. LA Levant Hal, "Introduction to Microprocessor, Software, Hardware, Programming", PHI, Inc.1978.
4. Mohamed Ali Mazidi, Janice Gillispie Mazidi, "The 8051 microcontroller and embedded systems using Assembly and C", 2nd Edition, Pearson education /Prentice hall of India , 2007.

Course Outcomes

After completion of the course the students are expected to be able to:

1. Understand the block diagram, Timing Diagram, Interrupt structure & configurations of 8085 and 8086 Microprocessors.
2. Comprehend the Functional block diagram ,Instruction format and addressing modes, Interrupt
   structure, I/O Ports and Serial communication of Microcontroller.
3. Interface ICs 8255 PPI, 8259 PIC, 8257 DMA, 8251 USART, 8279 Key board display controller and 8253 Timer/Counter, A/D and D/A converter.
4. Develop the programming skills in PID control algorithm to make various peripherals work for specified application.

Course No: MEC315	Course Title: Actuators, Drives and Sensors	L	P	U
		3	0	3

Learning Objectives

- To understand the fundamental concepts of electro-mechanical and fluid power (hydraulics and pneumatics) systems
- Apply these fundamental concepts to the modeling, analysis, and control of brushed dc motors, stepper motors, brushless dc motors, solenoids, and hydraulic and pneumatic actuators.
- To get familiarize with sensors used in engineering

Course Contents

UNIT-I

Introduction, Classification of actuators, characteristics, Hydralic, Pneumatic and Electric activators. Hydraulic actuators - Linear actuator-Types , Rotary activators, Basic structure, Pneumatic activators, Components, Structure, Stroke Speed Regulation of Pneumatic Actuators. - Electro pneumatic and Electro hydraulic systems and controls.

UNIT-II

Electric activators, Servo Motors , DC/AC, Working principle, characteristics, classification, Speed control techniques and braking, Applications-Speed, direction and position control using H-bridge under PWM mode. Stepper Motor-Drive circuits for speed and position control-Servo motors-Linear motors-Relays- Power convertors.

UNIT-III

Piezoelectric actuator-Linear actuators Hybrid actuators- Applications, shape memory alloys actuator, magnetostrictive actuators, Electrostrictive actuators, Electro-and magnetorheological fluid actuators.

UNIT-IV

Drive or Transmission propose, conversion from rotary to linear and vice varsa, load and power requirement, direct drives, gear box, belt and chain, harmonic drives, ball screw, rack pinion arrangements, four bar mechanism drives.

UNIT- V

Sensors introduction, desirable features, internal state sensors and external state sensors, joint sensors, Opto-electronic sensors, Magnetic sensors, Digital encoders, contact and non contact sensors, tactile and proximity sensors, slip sensors, range sensors, vision sensors, MEMS sensors and Bio sensors.

Text Books:

1. Andrzej M Pawlak , Sensors and Actuators in Mechatronics: Design and Applications, CRC Press 2017.
2. Antony Esposito, Fluid Power Systems and Control (2013), Prentice-Hall.

Reference Books:

1. W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering (2011), Pearson Education.
2. Andre Veltman, Duco W.J. Pulle, R.W. De Doncker, Fundamentals of Electrical Drives (2007), Springer.
3. John G. Webster, Halit Eren, "Measurement, Instrumentation, and Sensors Handbook", (2014), Second Edition, CRC Press.
4. A Ghosal, Robotics: Fundamental concepts and analysis, OUP India, 2006

Course Outcomes:

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

- Have knowledge about of the working principles and architecture of a large number of actuators and their elements.
- Selection of actuators and its associated drivers for several working conditions.
- Have knowledge about the architecture and working principles of the most common electrical motor types.
- Choose and use hydraulic, pneumatic, electrical actuators and drives.
- At the end of the course, students will be to understand terms and sensors used in engineering applications.
- Design necessary drive system for various application.

Course No: MEC 321	Course Title: Mechatronics System Design	L	P	U
		3	0	3

Learning Objectives

- To enable the student to understand the modern mechatronics components;
- To present the underlying principles and alternatives for mechatronics systems design;
- To provide the student with the opportunity for hands-on experience with the related components of the technology for diverse domains of application;
- To develop the student's ability to evaluate appropriate technology and create and devise realistic industrial systems.

Course Contents

UNIT-I

Introduction to Mechatronics system – Key elements – Mechatronics Design process – Types of Design – Traditional and Mechatronics designs – Advanced approaches in Mechatronics – Man machine interface, industrial design and ergonomics, safety.

UNIT II

Real-time interfacing – Introduction - Elements of data acquisition and control - Overview of I/O process, Analog signals, discrete signals, and Frequency signals – Over framing.

UNIT III

Case studies on Data Acquisition: Introduction – Cantilever Beam Force Measurement system–Testing of Transportation bridge surface materials – Transducer calibration system for Automotive applications – Strain gauge weighing system – Solenoid Force-Displacement calibration system – Rotary optical encoder – Controlling temperature of a hot/cold reservoir – pick and place robot.

UNIT IV

Case studies on Data Acquisition and control: Introduction – Thermal cycle fatigue of a ceramic plate – pH control system – Dc-Icing Temperature Control system – Skip control of a CD Player – Autofocus Camera, exposure control. Case studies of design of mechatronic products – Motion control using D.C.Motor & Solenoids – Car engine management systems.

UNIT V

Advanced applications in Mechatronics: Sensors for condition Monitoring – Mechatronic Control in Automated Manufacturing – Artificial intelligence in Mechatronics – Fuzzy Logic Applications in Mechatronics – Microsensors in Mechatronis.

Text books:

1. Devdas shetty, Richard A. Kolk, "Mechatronics System Design", Thomson Learning Publishing Company, Vikas publishing house, 2001.

Reference books:

1. Bolton, -Mechatronics - Electronic Control systems in Mechanical and Electrical Engineering-, 2nd Edition, Addison Wesley Longman Ltd., 1999.
2. Brian Morriss, Automated Manufacturing Systems - Actuators, Controls, Sensors and Robotics, Mc Graw Hill International Edition, 1995.
3. Bradley, D.Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Processes, Chapman and Hall, London, 1991.

Course Outcomes

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

- Ability to analyze electric and electronic circuits.
- Ability to automate data acquisition (based on a microcontroller and peripherals).
- Ability to interface hardware (microcontroller and peripherals) and software (assembly and/or C).
- Ability to use computer software to analyze and solve problems.

Course No: MEC322	Course Title: Autotronics	L	P	U
		3	0	3

Learning Objectives

- To impart knowledge on the engine technology
- To develop and understand the principles of conversion in design, construction and working of electronic systems in automobiles.
- To understand mechanical analysis and design combined with the advancement of sensor and microcontroller technology as well as standardization of communication protocol.
- To provide on board understanding of all contextualized elements related to the electronic system and diagnosing the same.

Course Contents

UNIT-I

Fundamentals of Automotive Electronics: Use of Electronics in automobiles, evaluation of autotronics, physical configuration of automobile, Systems: Chasis, Engine, drivetrain, suspension, steering, brakes and chasis. Microprocessor and micro Computer applications in automobiles;

UNIT-II

Components for engine management System; electronic management of chassis system; vehicle motion control; electronic panel meters. Digital Engine Control System: Open loop and closed loop control system;

UNIT-III

Electronic Fuel Injection & Ignition System: Introduction; Electronic controls of carburetion, feedback carburetor system; Throttle body injection and multi point fuel injection System; injection system controls; advantage of electronic ignition systems; types of solid state system and their principle of operation; electronic spark timing.

UNIT-IV

Engine cooling and warm-up control; acceleration, deceleration and idle speed control; integrated engine control system; exhaust emission control engineering; on-board diagnostics; future automotive electronic systems. Security and warning system.

UNIT-V

Sensors & Actuators: Introduction; Basic sensor arrangement; Types of Sensors such as oxygen sensors, Crank angle position sensors, fuel metering/vehicle speed sensors and detonation sensors, altitude sensors, flow Sensors, throttle position sensors, solenoids, stepper motors, relays. Electronic dash board instruments - Onboard diagnosis system.

Text Books:

1. Ronald K. Jurgen, Automotive Electronics Handbook, McGraw Hill Publishing Co., ISBN 007-034453-1.

Reference Books:

1. N. R. Khatawale, Automotive Electrical auxiliary systems
2. Al Santini, Automotive Electricity and Electronics, Delmar Publishers, NY, ISBN0-82736743-0.
3. Young, Griffitns, Automobile Electrical & Electronic Equipment's, Butterworth Publication, London.
4. Bechfold, Understanding Automotive Electronics, SAE 1998

Course Outcomes

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

- Will be able to understand the different automotive electrical systems, energy storages and ignition systems and the electronic components involved
- Developing the process of learning through a comprehensive educational plan
- The student will be in position to identify the fault diagnosis and preventive measures.
- Introducing the importance of this advanced technology to the public with the aid of providing appropriate atmosphere to create and distinguish.

Course Code	Course Title	L	P	U
MEC323	Manufacturing Process	**3**	**2**	**4**

Course Objectives:

1. To inculcate specialized knowledge and skill in manufacturing processes using the principles and methods of engineering analysis and design.
2. To cultivate the ability to develop and implement new improved manufacturing processes resulting in creation and distribution of value in engineering applications.
3. To learn the various methods and types of castings, welding processes, sheet metal forming.
4. To impart knowledge on selection of suitable manufacturing process for the typical components.

COURSE CONTENTS

UNIT – I

Understanding Manufacturing: concept of manufacturing, need, scope, advantages, limitation, application, materials and manufacturing, classification of manufacturing, process capabilities, selection, break even analysis of manufacturing processes.

UNIT – II

Casting: approach, steps, pattern, molding, gate and riser, melt treatment, solidification, casting processes: sand mould, shell mould, permanent mould casting, casting defect and their remedy.

Forming: approach, hot and cold forming, rolling, forging, extrusion, drawing, sheet metal forming, press, dies, types of dies and die set sheet metal operations punching, blanking, notching, nibbling.

UNIT –III

Joining: approach, need, principle of fusion welding, gas welding, thermit welding, arc welding common arc welding processes, resistance welding, weldability of metals, solidification of weld, weld discontinuities and their remedy.

UNIT- IV

Machining: approach, mechanism, classification, cutting tool, tool material, heat generation, cutting fluid, grinding, internal and external surface grinding, centerless grinding designation

and selection of grinding wheel, trueing and balancing, honing, reaming, lapping, polishing etc.

UNIT- V

Improving properties: heat treatment of steel and aluminum alloys, Fe-C diagram, TTT diagram, and CCT diagram, heat treatment processes annealing, normalizing, quenching tempering, surface modification methods namely without change chemistry, changing chemical composition and development of coating and cladding.

Textbooks:

1. "Manufacturing Engineering and Technology", Kalpakjian and Schmid, Prentice Hall, New Jersey, 2013.
2. "Fundamentals of Modern Manufacturing", Mikell P. Groover, John Wiley & Sons, Inc, New Jersey, 2010.

Reference Textbooks:

1. "Materials and Processes in Manufacturing", DeGarmo, Black, and Kohser, John Wiley & Sons, Inc, New York, 2011.
2. "Manufacturing Science" by Ghosh A and Mallick A K
3. "Manufacturing Technology: Foundry, Forming and Welding" by Rao P N
4. "Introduction to Manufacturing Processes" by Schey J
5. "Materials and Processes in Manufacturing" by DeGarmo E P and Black J T and Kohser R A.

Course Outcomes: On completion of the course, the student will be able to,

1. Recognize the different types of casting process.
2. Select suitable manufacturing process for typical components.
3. Describe the various welding process.
4. Explain the concept of forging, rolling process and drawing

Course No: ME324	Course Title: Machine Perception	L	P	U
		3	0	3

Learning Objectives

- To educate students in design and development of machine perception system for industrial applications.
- To understand the various hardware components of machine perception system.
- To build Machine-learning algorithms for input recognition, computer vision and image classification.
- To design automatically find, segment and track objects in scenes, perform face recognition and build three-dimensional models from images.

Course Contents

UNIT-I

Introduction, definition, human visual system, Active vision system, machine perception & its components and Computer Vision – HMI. Competing technologies, principle, MVS camera - Analog, Digital , Camera Calibration - Frame Grabber, Manual & Auto shutter and data capture. Triangulation geometry, resolution, passive and active 3-D stereo imaging, data processing.

UNIT-II

Fundamentals of Digital Image- Image classification, Inpt recognition, Filtering technique-Processing of binary and grey scale images-segmentation-thresholding-connectivity-noise reduction-edge detection-region growing and region splitting - binary and gray morphology operations.

UNIT-III

Conventional Newral networks, recurrent newral network-LSTM, GRU, Backpropogation through time, segmentation, generative adversarial networks, single perception, multilayer perception, tensor board

UNIT-IV

Logic, Inference, Ontology, Automated Planning and Acting, Uncertainty, Graphical Models, and Probabilistic Reasoning, Temporal Probabilistic Reasoning and Dynamic Bayesian Networks, Complex Decision-Making, Template Matching -Decision Making, 3D Machine Perception Techniques

UNIT- V

Applications of machine perception in Automotive Industries, Manufacturing, Electronics, Printing, Pharmaceutical, Biomedical, Robotics, Agricultural Industries.

Text Books:

1 E. R. Davies, *Machine Vision: Theory, Algorithms, Practicalities*, Academic Press, 2014.

Reference Books:

1. Alexander Hornberg, *Handbook on Machine Vision,* Wiley, 2006.
2. Herbert Freeman, *Machine Vision: Algorithms, Architectures and Systems,* Academic Press, 2012.
3. Computer Vision: Algorithms and Applications by Richard Szeliski (optional)
4. Russell, S. J. and Norvig, P. (2010). Artificial intelligence: A modern approach (3rd edition). Prentice-Hall.
5. Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing Analysis and machine Vision*, Cengage Learning, 2014.

Course Outcomes

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

- Understand and apply a series of probabilistic models of images and objects in machine perception systems.
- Understand the principles behind face recognition, segmentation, image parsing, super-resolution, object recognition, tracking and 3D model building.
- Apply machine perception concepts to electronic, manufacturing, automobile, pharmacy and packaging industries.

Course No: MEC325	Course Title: Micro Electro Mechanical Systems (MEMS)	L	P	U
		3	0	3

Learning Objectives

- To provide the fundamentals of MEMS and their applications.
- To understand different materials and their properties used for MEMS.
- To understand the concepts of various sensors and actuation systems used in MEMS.
- To appreciate the MEMS manufacturing techniques such as microfabrication, micro-machining.
- To understand and apply the principles of optical, Polymer and Bio-MEMS in the design of MEMS.

Course Contents

UNIT-1 INTRODUCTION TO MEMS AND MICROFABRICATION

History of MEMS Development, Characteristics of MEMS miniaturization, micro-electronics integration, Mass fabrication with precision. Micro fabrication - microelectronics fabrication process, silicon based MEMS processes, new material and fabrication processing, points of consideration for processing.

UNIT-2 ELECTRICAL AND MECHANICAL PROPERTIES OF MEMS MATERIALS

Conductivity of semiconductors, crystal plane and orientation, stress and strain, definition, relationship between tensile stress and strain, mechanical properties of silicon and thin films, Flexural beam bending analysis under single loading condition- Types of beam, deflection of beams, longitudinal stain under pure bending, spring constant, torsional deflection, intrinsic stress, resonance and quality factor.

UNIT-3 SENSING AND ACTUATION

Electrostatic sensing and actuation, parallel plate capacitor, applications of Inertial, pressure and tactile sensor parallel plate actuator, comb drive. Thermal sensing and Actuations, thermal sensors, Actuators, Applications, Inertial, Flow and Infrared sensors. Piezoresistive sensors, piezoresistive sensor material, stress in flexural cantilever and membrane, Application- Inertial, pressure, flow and tactile sensor. Piezoelectric sensing and actuation- piezoelectric material properties-quartz-PZT-PVDF–ZnO Application- Inertial, Acoustic, tactile, flow- surface elastic waves. Magnetic actuation- Micro magnetic actuation principle, deposition of magnetic materials, Design and fabrication of magnetic coil.

UNIT-4 BULK AND SURFACE MICROMACHINING

Anisotropic wet etching, Dry etching of silicon, Deep reactive ion etching (DRIE), Isotropic wet etching, Basic surface micromachining process- structural and sacrificial material, striction and antistriction methods, Foundry process.

UNIT-5 POLYMER, OPTICAL AND Bio-MES

Polymers in MEMS- polymide SU-8 liquid crystal polymer(LCP), PDMS, PMMA, Parylene-Flurocorbon, Applications, Acceleration, pressure, flow and tactile sensors.

Optical MEMS- passive MEMS optical components, lenses, mirrors, Actuation for active optical MEMS.

Bio MEMS- Introduction, Microfabrication of silicon, glass, and polymer devices, Microfluidics and electro-kinetics, drug-delivery systems, Micro-total-analysis systems (μTAS) and lab-on-a-chip devices (LOC), Detection and measuring systems.

Text Books:

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
2. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.
3. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.

Reference Books:

1. Nadim Maluf, "An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
2. Mohamed Gad,el,Hak, editor, "The MEMS Handbook", CRC press Baco Raton, 2001.
3. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
5. Thomas M.Adams and Richard A.Layton, "Introduction to MEMS, Fabrication and Applications," Springer, 2010.

Course Outcomes

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

- Understand the basic principles of operation of micro devices, micro systems and their applications.
- Select suitable sensors for different applications of MEMS.
- Design the micro devices, micro systems using the MEMS fabrication process.
- Apply the concepts for manufacture of polymer and BioMEMS systems

Course No: **MEC401**	Course Title: **Advances in Robotics**	L	P	U
		3	0	3

Course Learning Objectives

- Understanding the flexible manipulators and modeling and control of flexible serial robots.
- Classify the mobile robots, wheelded and legged locomotion, modeling of slip, and design of slip-free wheeled mobile robot
- Analyze Stewart platform and its singularities, use of singularities for fine motion and sensing, and design of Stewart platform based sensors.
- Understand the concept of over-constrained mechanisms and deployable structures.
- Desgin and build an Aerial robots..etc

Course Contents

UNIT-I

Models of flexible links and joints, Kinematic modeling of multi-link flexible robots, Dynamics and control of flexible link manipulators, Numerical simulations results, Experiments with a planar two-link flexible manipulator.

UNIT-II

Introduction and some well known mobile robots , legged and wheeled mobile robots, two and three-wheeled WMR on flat surfaces, Slip and its modeling, WMR on uneven terrain, Design of slip-free motion on uneven terrain, Kinematics, dynamics and static stability of a three-wheeled WMR's on uneven terrain, Simulations using Matlab and ADAMS.

UNIT-III

Introduction to chaos, Non-linear dynamics and chaos in robot equations, Simulations of planar 2 DOF manipulators, Analytical criterion for unforced motion. Gough-Stewart platform and its singularities, use of near singularity for fine motion for sensing, design of Gough-Stewart platform based sensors.

UNIT-IV

Over-constrained mechanisms and deployable structures, Algorithm to obtain redundant links and joints, Kinematics and statics of deployable structures with pantographs or scissor-like elements (SLE's).

UNIT-V

Introduction to Unmanned Aerial Vehicle, basic mechanics and control strategies, kinematics of quadrotors, dynamic equations of motion, 1-D quadrotor control, 3-D dynamic model, building and programming a quadrotor .

Text Books:

3. Ashitava Goshal, Robotics: Fundamental concepts and Analysis, Oxford university press, 2010.

Reference Books:

1. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Pearson Education.

2. Murray, R., Li, Z. and Sastry, S., A mathematical introduction to robotic manipulation. CRC Press, 1994

3. Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles By Kenzo Nonami et al Springer 2010.

Course Outcomes

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

- Describe and explain the advanced concepts on robotics like flexible manipulators, mobile robots etc
- Select and identify suitable elements for making quadrotor
- Demonstrate self learning capability

Course No: **MEC402**	Course Title: **HAPTICS**	L	P	U
		3	0	3

Course Learning Objectives

- Understand the basics haptic system, rendering, teleoperation..etc
- Design and build, program and control haptic devices
- Experience rendering virtual objectives using a variety of techniques
- capabilities and limitations of human touch, develop an intuitive connection between equations and feel

Course Contents

UNIT-I
Introduction to haptic technology and human haptics, history and origin of haptics, kinesthetic haptic devises, tactile devices, kinematics and dynamics, Haptic mechatronics, sensors and actuators.

UNIT-II
1-DOF and multi degree of freedom rendering, basic algorithm, collision detection, dynamic simulation.

UNIT-III
Hapkit, distribution and assembly, Teleoperation, implementation, transparency and stability, mechanoreptors.

UNIT-IV
Design and programming of haptic system, the phantom, the cybergrasp, programming in virtual environments, programming a feedback system

UNIT-V
Control of Haptic system, characterization of devices, vibration and tactile arrays, thermal stimulation, haptic flow.

Text Books:

Because a comprehensive book on the field of haptics does not yet exist, this class has no textbook. Instead, selected readings will be handed out each week and made available to the students.

Reference Books:

1. IEEE transactions on Haptics
2. Symposium and Conference proceeding of Haptics
3. http://www.cs.ualberta.ca/~pierreb/Haptics-2008.html
4. S. Clapan and F. G. Hamza-Lup (2008) "Simulation and Training with Haptic Feedback—A Review," 3rd International Conference on Virtual Learning (ICVL), 31 October – 2 November, Constanta, Romania.
5. K. E. MacLean. Haptic interaction design for everyday interfaces. Reviews of Human Factors and Ergonomics, 4:149-194, 2008
6. K. Salisbury, F. Conti, and F. Barbagli. Haptic rendering: Introductory concepts. IEEE Computer Graphics and Applications, 24(2):24-32, 2004

Course Outcomes

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

- How to build, program, and control haptic devices
- Device modeling, synthasyse and analysis of a haptic system
- Demonstrate self learning capability.
- With these skills the students can apply the haptic understanding into various applications.
- The students are employable in the companies pertaining to Haptics, design, human machine interactions, etc.

Course No: **MEC403**	Course Title: **Computational Motion Planning**	L	P	U
		3	0	3

Course Learning Objectives

- To learn the concepts of motion planning.
- To develop and analyze algorithms for motion planning.
- To implement motion planning algorithms efficiently for use in research or industry.
- To learn the concepts of potential functions, visibility graphs and coverage planning.

Course Contents

UNIT-I

Introduction; robotics and autonomous systems; workspaces; configuration spaces; planning algorithms; Introduction to discrete planning; state space models and examples; discrete feasible planning; graph search algorithms; Dijkstra's algorithm; A*; systematic searches; configuration spaces revisited; mechanical linkages; forward and inverse kinematics. Visualizing high dimensional configuration spaces; polygonal robots and obstacles; representing polygonal objects; star algorithm.

UNIT-II

Holonomic constraints; degrees of freedom in a configuration space; rigid bodies in 3D; Euler parameterization; Quaternion algebra; Gimbal lock problem; Rotations and translations of points and bodies; types of joints; kinematic chains; Introduction to roadmaps; deterministic/combinatorial methods for roadmap construction; general properties; visibility graphs. Generalized voronoi diagrams (GVD); bush-fire algorithm; Potential field methods; vector fields and gradients; gradient descent algorithm.

UNIT-III

Introduction to navigation functions; Star-shaped worlds; diffeomorphisms; mapping stars to spheres; navigation functions for star worlds. Cell decomposition; Trapezoidal cell decompositions; modified potential field method for direct workspace control; Introduction to sampling based planning.

UNIT-IV

Probabilistic roadmaps algorithm (PRM); query phase of PRM; rapidly exploring random trees and variants; Learning phase in PRM algorithm; sampling difficulties and narrow passages. Introduction to probabilistic robotics; modeling sensor noise; state and measurement; Discrete-time linear models from equations of motion.

UNIT- V

Derivation of the Bayesian filter; Derivation of the Kalman filter. Introduction to Simultaneous Localization and Mapping (SLAM); Basic SLAM using Kalman filtering; non-linear models of sensing and robot motion; Probabilistic localization using Bayesian filtering.

Text Books:

1. Choset, Howie M. Principles of robot motion: theory, algorithms, and implementation. MIT press, 2005.

Reference Books:

1. Steven M. LaValle, Planning Algorithms, Cambridge University Press, 2006.
2. S. Thrun, W. Burgard, D. Fox, R.C. Arkin, Probabilistic Robotics, MIT Press, 2005.
3. J.C. Latombe, Robot Motion Planning, Springer science+Business Media, New York, 1991.

Course Outcomes

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

- To model and simulate robotic mechanisms.
- To analyze limitations of motion and sensing in motion planning.
- To implement motion planning methods in complex uncertain environment.
- To integrate control, planning and reasoning problems in autonomous systems.
- Skills in revamping the addressing structure of solving the problems with the algorithm studied under this course content.
- Employable chances are very high as the computational approach in problem solving will be highly appreciated by various undustries and specially with this content the students opprutnites are widened.

Course No: **MEC404**	Course Title: **Humanoids**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

The course aims at giving the students

- A basic understanding of the theory of humanoid robots, i.e. bipedal walking robots with an approximately humanlike shape, and
- Practical knowledge concerning humanoid robots, through a robot construction project.

Course Contents

Unit 1:

Theory of humanoid robots, kinematics and dynamics.

Unit 2:

Methods for gait generation, including classical control theory, central pattern generators and linear genetic programming.

Unit 3:

Applications of humanoid robots.

Unit 4:

Humanoid robots in society - current and future applications, comparison with other types of robots.

Unit 5:

Hardware construction, including the use of microcontrollers and servo motors in connection with humanoid robots.

Text:

(1) Etienne Burdet, David W. Franklin, and Theodore E. Milner, Human Robotics: Neuromechanics and Motor Control, MIT Press, 2013

(2) Reza Shadmehr and Steven P. Wise, The Computational Neurobiology of Reaching and Pointing: A Foundation for Motor Learning, MIT Press, 2004

References:

(1) Jack Williamson, The Humanoids: A Novel , Orb Books, – January 15, 1996

(2) Ambarish Goswami, Prahlad Vadakkepat, Humanoid Robotics: A Reference Springer, 5 Nov 2018

(3) Dragomir N. Nenchev, Atsushi Konno , Teppei Tsujita, Humanoid Robots: Modeling and Control, Butterworth-Heinemann, 26 Nov 2018

Course Outcomes:

Students are able to

- Understand and describe the basic properties of humanoid robots.
- Implement and apply different methods for bipedal gait generation, such as e.g.central pattern generators and linear genetic programming.
- Implement other motor behaviors (such as dexterous manipulation) for humanoid robots.
- Discuss and describe the advantages and disadvantages of humanoid robotics in relation to other kinds of robots.
- Describe the potential uses of humanoid robotics in society.
- Construct a part (e.g. a head or an arm) of a humanoid robot, and use the construction in a variety of experiments.
- The sills enhanced through this course is practical understanding of inventing the humanoids and its various applications.
- The employability fo the students are very high as this vertical of consumer applications will be keep enhancing.

Course No: **MEC405**	Course Title: **Human Robot Interaction (HRI)**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

- To understand the basics of HRI
- Analyse and design robot with HRI
- Understanding of robot with HRI
- Ability to create a robot with HRI model for specific application

Course Contents

UNIT-I

Introduction to Robotics, configurations of humanoid robots, applications of humanoid robots, introduction to Human Robot Iinteraction Theory and evaluation of human robot interactions

UNIT-II

Methodology and themes of human-robot interaction Classifying human-robot interaction Autonomy and Perception of human robots Critical considerations for human-robot interface development.

UNIT-III

Enhancing a Human-Robot Interface using Sensory EgoSphere automation strategies of HRI enhanced human-robot interface Improving Human-Robot Interaction through Interface Evolution Speaking Swarmish Human-robot interaction in rescue robotics

UNIT-IV

Design of human centered robotic systems Metrics for evaluating human-robot interactions design of a highly reliable robot for unmediated museum interaction Generalizable Metric Classes to Evaluate Human-Robot

UNIT- V

Human-robot interactions during the robot-assisted urban search predictive metrics for supervisory control of multiple robots, Remote control units for industrial robots HRI for service robots, HRI Applications

Text Books:

1. Human-Robot Interaction by Waldemar Karwowski, Mansour Rahimi CRC Press.

Reference Books:

1. Trends in Control and Decision-Making for Human–Robot Collaboration Systems Edited by Yue Wang, Fumin Zhang
2. Emotional Design in Human-Robot Interaction: Theory, Methods and Applications Hande Ayanoglu, Emilia Duarte Springer International Publishing,
3. New Frontiers in Human Robot InteractionKerstin Dautenhahn, Joe Saunders John Benjamins Publishing

Course Outcomes

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

- Able to explain and discuss basic HRI theory, terms, and principles
- Apply HRI principles to design a robotic system
- Able use practical knowledge of HRI to complete a research project and present it to an interdisciplinary audience.
- With the skills of HRI the students were able to create a medium for communication between the human and robotics with various algorithm pertaining to their applications.
- The employability is high as the future turns with the robotics and its interaction.

Course No: **MEC406**	Course Title: **Mobile Robotics**	L	P	U
		3	0	3

Course Learning Objectives

To provide an overview of problems /approaches in mobile robotics

- To develop Hands-on experience
- To enable a novice to understand how the robot works
- To Focus on automated reasoning and knowledge representation
- To develop probabilistic reasoning: Dealing with noisy data

Course Contents

UNIT-I

Introduction to mobile robotics: Introduction, Concept , Definition , Historic Evolution, Mobility and Autonomy, Wheeled mobile robots, legged mobile robots, human like leg, animal like leg, recent projects and applications.

UNIT-II

Legged locomotion , hopping on plane, 3D hopping , Biped and Quadruped , One foot gait, Kinematics for one legged, two legged and four legged machines, Dynamics and balance improvement, symmetry, control system for legged locomotion

UNIT-III

Probabilistic Sensor models: Robot Motion, Dynamic Bayesian Network for Controls, States, and Sensations, Typical Motion Models- wheel kinematics and constraints , Odometry-based, Velocity-based (dead reckoning), Reasons for Motion Errors of Wheeled Robots, Bayes Filter – Discrete Filters, Extended Kalman Filter.

UNIT-IV

SLAM - Simultaneous Localization and Mapping: SLAM Applications- vacuum cleaner, lawn mower, Air surveillance with unmanned air vehicles, underwater reef monitoring, underground exploration of mines.

UNIT- V

Techniques for 3D Mapping: Need for 3D Representation, Types of Representations- Point clouds, Voxel grids, Surface maps, Meshes. Elevation Maps, Extended Elevation Maps, MLS Map Representation,

Text books

1. Marc H Raibert., 'Legged robots that Balance', The MIT Press, Cambridge.
2. Murphy, Robin R., "Introduction to AI Robotics", The MIT Press, Cambridge, Massachusetts, 2001, 466 pp, ISBN 0–262-13383-0
3. Nehmzow, Ulrich "Mobile Robotics :A practical- Introduction" Springer London Ltd, 2009, ISBN: 9781852331733, 1852331739

Reference Books

1. Arkin, Ronald C., "Behavior-Based Robotics", The MIT Press, 1998
2. Bekey, George A., "Autonomous Robots: From Biological Inspiration to Implementation and Control", The MIT Press, 2005
3. Jones, Joseph L., Flynn, Anita, M., and Seiger, B.A., "Mobile Robots: Inspiration to Implementation", AK Peters, 1999
4. Martin, Fred G., "Robotic Explorations: An Introduction to Engineering through Design", Prentice Hall, 2001

Course Outcomes

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

- Design a simple path and motion planning robot.
- Elucidate and design the applications of SLAM
- Illustrate the function of application specific Tasks of Mobile Robots.
- Skills of implementing and understanding of various algorithms in guiding the robitcs is covered through this content.
- Emplyability is high as the customization of the robotics need to be addressed as per the future requirements and can be studied through this content.

Course No: **MEC407**	Course Title: **Unmanned Aerial Vehicles**	L	P	U
		3	0	3

Course Learning Objectives

- To develop an overall understanding of UAV history, types, and operational safety and rule-compliance requirements.
- To obtain basic knowledge of UAV elements, aerodynamics, and flight dynamics.
- To gain knowledge of UAV guidance, navigation and control.
- To acquire basic knowledge of UAS payloads and the enabled ConOps (concept of operations).
- To obtain basic knowledge of UAS mission planning.

Course Contents

UNIT-I

Introduction to Unmanned Aerial Vehicle (UAV): History of UAV. Applications of UAV. Aviation regulations. The system in UAV. Classification of UAVs. Safety assessment and Human factors in UAV. Design considerations- Environment, budget and time, airframe design and payload.

UNIT-II

Selection of hardware: Propulsion, navigation and flight control systems. Autopilot systems and ground control station. MEMS sensors used in UAVs. Inertial Measuring Units (IMU). Gyroscope and GPS.

UNIT-III

Design of fixed wind UAV: Determination of mass and inertial characteristics. Centre of gravity measurement- knife edge method. Determination of I_y- bifilar suspension method. Determination of I_x and I_z. Determination of wing characteristics. Calculation of wing area (S), mean aerodynamic chord, and wing loading.

UNIT-IV

UAV structural design: Wing structural details- spars, ribs, skin, stringers. The flight and gust envelopes. The tail load envelope. Safe life and fail safe design philosophies, and good design practice.

UNIT- V

UAV subsystem nexus: The electrical system, communication systems, command and control, unmanned aircraft subsystem integration. Detect and avoid, policy and public perception, and future of unmanned aerial vehicles.

Text Books:

1. Douglas M. Marshall, Richard K. Barnhart, Stephen B. Hottman, Eric Shappee, Michael Thomas Most, "Introduction to Unmanned Aircraft Systems", CRC Press, 2016.
2. Randal W. Beard & Timothy W. McLain, "Small Unmanned Aircraft: Theory and Practice" Princeton University Press, 2012.
3. Reg Austin, "Unmanned Aircraft Systems: UAVS Design, Development and Deployment". Wiley publications, 2010.

Reference Books:

1. Valavanis, Kimon P, Vachtsevanos, George J. (Eds.), "Handbook of Unmanned Aerial Vehicles" Springer, 2015.
2. Paul Fahlstrom, Thomas Gleason, "Introduction to UAV Systems", 4th Edition, ISBN: 978-1-119-97866-4; 306 pages; September 2012.
3. Haiyang Chao and YangQuan Chen, "Remote Sensing and Actuation Using Unmanned Vehicles", Wiley-IEEE Press, 2012.

Course Outcomes

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

- Understand and operate typical civilian low cost unmanned aerial vehicles.
- Integrate typical mission sensors in civilian low cost unmanned aerial vehicles.
- Get ready to create UAV related engineering practice/service or to join UAV work force.
- Skills in practically inventing the UAV with the content covered and employability is high as the future is turning towards it.

Course No: **MEC408**	Course Title: **Autotronics**	L	P	U
		3	0	3

Course Learning Objectives

- To impart knowledge on the engine technology
- To develop and understand the principles of conversion in design, construction and working of electronic systems in automobiles.
- To understand mechanical analysis and design combined with the advancement of sensor and microcontroller technology as well as standardization of communication protocol.
- To provide on board understanding of all contextualized elements related to the electronic system and diagnosing the same.

Course Contents

UNIT-I

Fundamentals of Automotive Electronics: Use of Electronics in automobiles, evaluation of autotronics, physical configuration of automobile, Systems: Chasis, Engine, drivetrain, suspension, steering, brakes and chasis. Microprocessor and micro Computer applications in automobiles;

UNIT-II

Components for engine management System; electronic management of chassis system; vehicle motion control; electronic panel meters. Digital Engine Control System: Open loop and closed loop control system;

UNIT-III

Electronic Fuel Injection & Ignition System: Introduction; Electronic controls of carburetion, feedback carburetor system; Throttle body injection and multi point fuel injection System; injection system controls; advantage of electronic ignition systems; types of solid state system and their principle of operation; electronic spark timing.

UNIT-IV

Engine cooling and warm-up control; acceleration, deceleration and idle speed control; integrated engine control system; exhaust emission control engineering; on-board diagnostics; future automotive electronic systems. Security and warning system.

NIT-V

Sensors & Actuators: Introduction; Basic sensor arrangement; Types of Sensors such as oxygen sensors, Crank angle position sensors, fuel metering/vehicle speed sensors and detonation sensors, altitude sensors, flow Sensors, throttle position sensors, solenoids, stepper motors, relays. Electronic dash board instruments - Onboard diagnosis system.

Text Books:

2. Ronald K. Jurgen, Automotive Electronics Handbook, McGraw Hill Publishing Co., ISBN 007-034453-1.

Reference Books:

5. N. R. Khatawale, Automotive Electrical auxiliary systems
6. Al Santini, Automotive Electricity and Electronics, Delmar Publishers, NY, ISBN0-82736743-0.
7. Young, Griffitns, Automobile Electrical & Electronic Equipment's, Butterworth Publication, London.
8. Bechfold, Understanding Automotive Electronics, SAE 1998

Course Outcomes

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

- Will be able to understand the different automotive electrical systems, energy storages and ignition systems and the electronic components involved
- Developing the process of learning through a comprehensive educational plan
- The student will be in position to identify the fault diagnosis and preventive measures.
- Introducing the importance of this advanced technology to the public with the aid of providing appropriate atmosphere to create and distinguish.
- With the combination skills of automobile and robotics will enhance the students to apply their understanding in the fields of automotive and electronics areas and also get employable with the organizations pertaining to it.

Course No: **MEC409**	Course Title: **Bio Mechanics**	L	P	U
		3	0	3

Course Learning Objectives

- Identify a given bone, ligament or muscle by name, anatomic location, or function.
- Recall the general characteristics, material properties, appropriate constitutive model, and adaptation potential for tissue and organs studied.
- Identify relationships between structure and function in tissues and the implications/importance of these relationships.
- Analyze the forces at a skeletal joint for various static and dynamic human activities.
- Analyze the stresses and strains in biological tissues, given the loading conditions and material properties.
- Identify the appropriate viscoelasticity model for the mechanical behavior of a given biological tissue.
- Predict the overall creep and stress relaxation behavior for a basic viscoelastic material model.

Course Contents

UNIT-I

Introduction to Biomechanics – Terminology – Anthropometry – Skeletal Mechanics – Structure of bones – Composition and properties of bones and relationship to structure – Elastic properties of bones – Characterizing elastic anisotropy - Modeling and Remodeling of bones (Wolfe's law of bone remodeling).

UNIT-II

Structure and function relationships in tissues and organs; application of stress and strain analysis to biological tissues; analysis of forces in human function and movement; energy and power in human activity; Viscoelasticity of soft tissues – Models of viscoelasticity (Maxwell, Voigt, Kelvin),

UNIT-III

Muscle mechanics – Muscle architecture and mechanics – Muscle fascicles and their arrangement – Fiber architecture in fascicles – Muscle as a fiber reinforced composite – Muscle centroids – Muscle Cross sectional areas (Physiological & Anatomical) – Properties of tendons and passive muscles.

UNIT-IV

Viscoelastic behavior of tendons – Tendon interaction with surrounding tissues – Mechanical properties of passive muscles. Mechanics of Active muscle: Muscle force production and transmission – Functional relations (Force - length, Force – Velocity curves), History effects in muscle mechanics – Hill's model (derivation) – Sliding filament theory.

UNIT-V

Muscle coordination – Problem of motor redundancy – Approach to studying muscle force production using optimization (forward and inverse) Exemplary behavior: Dynamics of Reaching – Inverse dynamic modeling

Text book

1. David Goldsheyder, Dawn Leger, Margareta Nordin, and Nihat Ozkaya, Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, Springer, 1999, 2nd edition.

Reference books:

1. Margareta Nordin and Victor Hirsch Frankel, Basic Biomechanics of the Musculoskeletal System, Lippincott williams & wilkins, 2001, 3rd edition
2. Peter R. Hoskins, Patricia V. Lawford, Barry J. Doy, Cardiovascular Biomechanics,
3. Springer, 2017.
4. Y. C. Fung Biomechanics: Mechanical Properties of Living Tissues, Springer, Springer, 1999, 2nd edition.

Course Outcomes

At the completion of this course it is desired that each student be able to:

- Describe motion with precise, well-defined mechanical and anatomical terminology;
- Understand and quantify linear and angular characteristics of motion;
- Understand the quantitative relationships between angular and linear motion characteristics of a rotating body;
- Understand and quantify the cause and effect relationship between force and linear and angular motion;
- Understand the mechanics of connective tissue and injury;
- Understand the kinetic and kinematic assessment of posture(s)
- Multidisciplinary skills of these content help the students to apply the knowledge of the mechanics in the field biomedical interms of equilibrium, motion, etc.
- With these contents the employability fo the students are very high in the areas of Medical, Instrumentation, etc

Course No: **MEC410**	Course Title: **Bio Mechatronics**	L	P	U
		3	0	3

Course Learning Objectives

- To know the principles, designs and applications of various flow measurement assisted devices for the human functional systems.
- To design and develop the cardiac devices like artificial hearts and stents.
- To design the implants and instrumentation for orthopaedic applications.
- To design and develop the active and passive prosthetic limbs, respiration systems, medical imaging.
- To design and develop sensors and smart actuators for biological applications.

Course Contents

UNIT-I

Introduction to Bio Mechatronics, Bio Sensors and Actuators; Electrodes - Types, - Measurement of blood pressure – Blood Gas analyzers: pH of blood, Smart actuators for biological applications.

UNIT-II

Medical Measurements; Heart rate - Heart sound - Pulmonary function measurements spirometer - finger-tip oximeter - ESR, GSR measurements and Signal Processing; Bio medical signals, Signal acquisition and signal processing-Isolation barriers, Bio-Image processing.

UNIT-III

Sensory Assist Devices; Hearing aids – Implants, Optical Prosthetics, Visual Neuroprostheses – Sonar based systems, Respiratory aids, Tactile devices for visually challenged.

UNIT-IV

Active and Passive Prosthetic Limbs; Introduction to prosthetics, Passive Prosthetics – walking dynamics, Knee and foot prosthesis. Active prosthesis - Control of Prosthetic Arms and Hands, Leg Mechanisms, Ankle–Foot Mechanisms, Prosthesis Suspension.

UNIT- V

Wearable mechatronics devices; Wearable Artificial Kidney, Wireless capsule endoscope, Wearable Exoskeletal rehabilitation system, Wearable hand rehabilitation,

Text Books:

1. Graham M. Brooker, "*Introduction to Bio-Mechatronics*", 1st edition, SciTech Publishing, 2012.

Reference Books:

1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, *Bio-Medical Instrumentation and Measurements*, 2nd edition, Pearson Education, 2009.
2. Raymond Tong Kaiyu, *Bio-mechatronics in Medicine and Healthcare*, Pan Stanford Publishing, CRC Press, 2011.

Course Outcomes

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

- Work and contribute on sensors and actuators used in biomedical system designs.
- Design and development of prosthetic limb
- Develop the hearing aid equipments
- Design Tactile devices for visually challenged people
- Use the CT & MRI data for engineering applications
- Design and development of cardiac devices like stent etc.,
- Design of implants and instrumentation for orthopaedic applications
- With the combination bio and mechatronics helps the students to approach a multi disciplinary in solving and apply the content into various biomedical, instrumentations, measurements, etc.
- The employability of the students are high in the insductries mentioned which are inline with Medical, Healthcare, etc.

Course No: **MEC411**	Course Title: **Protein Kinematics**	L	P	U
		3	0	3

Course Learning Objectives

- Introduces the fundamentals of biology for an engineer.
- Covers mechanisms and biomechanics of DNA, proteins, cells, connective tissue, musculoskeletal tissue, and cardiovascular tissue, integration principles of living systems,
- Structure-function relationships, and techniques to study biology and medicine, and tissue engineering.

Course Contents

Unit 1:

Introduction - Protein Structures, Amino Acid DOF, Example of a protein structure, Protein Function, Protein Folding, Prediction of Protein Fold.

Unit 2:

Kinematic Model notation and formulation, Protein Kinematic Model, Notation, Zero-Position Notation, Direct Kinematics, Force Field Model and Conformation Change,

Unit 3:

Mobility Analysis, Identification of Rigid and Flexible domains, Hydrogen Bonds form Closed Loops, Stiffness Analysis, Energy of hydrogen bonds.

Unit 4:

Parameter Calibrations, Conformation Pathways, Design of Feasible Conformations.

Unit 5:

Protein Path Planning for Crystallization, The Model of the Motion, Stability and Shape Analysis, Driving Force of the Motions of Proteins in Crystallization, vander Waals Force and the Local Motion, The Issue of Orientation

Text:

(1) Harmonic Analysis for Engineers and Applied Scientists: Updated and Expanded Edition. G. S. Chirikjian, A. B. Kyatkin. Dover Publications. July 2016.

(2) Stochastic Models, Information Theory, and Lie Groups: Volume 2 Analytic Methods and Modern Applications. G. S. Chirikjian. Boston: Birkhäuser. Nov. 2011.

References:

(1) Stochastic Models, Information Theory, and Lie Groups: Volume 1 Classical Results and Geometric Methods. G. S. Chirikjian. Boston: Birkhäuser. Sept. 2009.

(2) Please note the associated Addenda and Erratum.

(3) Engineering Applications of Noncommutative Harmonic Analysis. G. S. Chirikjian, A. B. Kyatkin. CRC Press. Oct. 2000.

Course Outcomes:

- describe the different levels of protein structure and their interdependence
- explain how steric limitations determine secondary structure in polypeptides
- describe, using examples, the relationship between protein structure and function
- Understanding the significance of domains in protein function and how they have arisen.
- With these skills the students can apply the study of various bonds, culture of proteins.
- Employable skills are covered with the content and gets into the jobs pertaining to the domain of Applied sciences.

Course No: **MEC412**	Course Title: **Neural Computation**	L	P	U
		3	0	3

Course Learning Objectives

- To understand the organization of the nervous system, brain and biological neurons.
- To understand the relationship between real brains and simple artificial neural network models.
- To explain the learning and generalization aspects of neural computation.

Course Contents

UNIT-I

Introduction : History of neural computing; Relationship to Artificial Intelligence, Biological background, Biological Neurons and Neural Networks, Artificial Neurons, The Nervous System , Levels of Brain Organization , Structure of a Human Brain , Basic Components of Biological Neurons, Neural Signal Processing, Basic synaptic mechanism and dendritic processing, The generation of action potentials, Neuronal morphologies.

UNIT-II

Neuron Models: Simplified Neuron and population Models, Basic spiking neurons, Spike time variability, the neural code and the firing rate hypothesis, Population dynamics, Networks with non-classical synapses

UNIT-III

Neural Mechanisms of Learning and Memory: Associative memory and Hebbian learning, Mathematical formulation Hebbian plasticity, Synaptic scaling and weight distributions.

UNIT- IV

Neural Networks: Organization in the brain, Information transmission in random networks, Simple and multilayer perception, Support vector machines, Auto associative network, Point attractor neural networks and sparse attractor networks.

UNIT- V

Motor control and Reinforcement learning: Modular mapping networks, Coupled attractor networks, Sequence learning, Complementary memory systems, Motor learning and control, Reinforcement learning. Cognitive brain: Hierarchical maps and attentive vision, An inter connecting work space hypothesis, The anticipating brain, Adaptive resonance theory.

Text Books:

1. Trappenberg T.P. (TTP), Fundamentals of computational neuroscience, 2nd edition, Oxford University Press, 2nd edition, 2010.

Reference Books:

1. J. Hertz, A. Krogh and R.G. Palmer, An Introduction to the Theory of Neural Computation, Addison Wesley, 1991

2. F. M. Ham and I. Kostanic, Principles of Neurocomputing for Science and Engineering, McGraw Hill, 2001.

3. Peter Dayan and L. F. Abbott, Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems, The MIT press.

Course Outcomes

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

- Understand the fundamental techniques and principles of neural computation.
- Investigate some common neural-based models and their applications.
- Present neural network models in the context of automated learning.
- With the skills of computational and numerical understanding of solving the problems helps the students apply them in the application sof various domain functionalities.
- With these skills the students are highly chances of getting employed in the R&D Centers and many research institutes.

Course No: **MEC413**	Course Title: **Soft Robotics**	L	P	U
		3	0	3

Course Learning Objectives

- To build intelligent machines purely out of stretchable compressible soft materials.
- To make robots soft so they can interact closely with humans and human bult environments.
- To understand about how to build, characterize and control soft robots.

Course Contents

UNIT-I

Introduction – development of more refined sensors – advances in computing and software technologies. Focus on soft, pliable, sensitive, organic representations.

UNIT-II

Sensors and actuators; concepts of distributed actuators and their control – Artificial muscles, made of Dielectric elastomer actuators – musculoskeletal robots and wearable devices -Capacitive tactile proximity sensing.

UNIT-III

Modeling, simulation and control; perception of deformable objects – soft robot control – optimal exploitation of soft-robot dynamics – simulation technology – concepts of softness – Mechanics and thermodynamics of biological muscle.

UNIT-IV

Materials, design and manufacturing; Nano structured materials – Fibrous material and Textiles – aspects of human engineering, bio- optimized design – 3D printed objects.

UNIT- V

Soft robotic applications; Soft hands for reliable grasping strategies – variable stiffness actuators – tough robots for soft human robot interaction- Flexible robot for laser phono microsurgery – soft components for soft robots.

Text Books:

1. Alexander verl and Alin albu, *Soft Robotics: Transferring Theory to Application,* Springer, 2015

Reference Books:

1. Mathew borgatti, Kary love , *Soft Robotics*, Maker media, Inc, 1st edition, 2018

Course Outcomes

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

- Describe open questions in soft robotics by way of literature review.
- Develop a research plan and methodology for a soft robot project.
- Produce novel soft robotic systems.
- Students are capanle of completely developing the robotics systems with their unique approach after completion of the course.
- The students are capable of getting employed in the domain area of the Robotics.

Course No: **MEC414**	Course Title: **Medical Devices**	L	P	U
		3	03	

Course Learning Objectives

- Give a vivid idea about mobile robots in medical devices to students' researchers & industry people in the current field.
- Give the basis of robot sensing and contolling syetems along with the concept & process of human –robot interference
- providing konwledge with the state of the art in applied medical robotics and medical robotics research
- Provide an Understanding of various roles that robotics can play in healthcare

Course Contents

UNIT-I

Introduction to Robotics–Why to use robots in Health care; Medical device Automation, Flexibility, Tracability verifiability in usage, Concept of AICETA, Mobile Robot localization.

UNIT-II

Range of Robots usage—manufacturing of medical devices to medical surgeries. Medical assembly robots produce medication, diagnostic test kits, syringes and devices of every kind. Packaging robots fill individual primary packaging like packs and bottles, as well as secondary packaging such as cases and trays. Robots are even useful for palletizing; Workspace Identification.

UNIT-III

Types of Applications; Different solutions for medical robotics offered by the companies, such as the delta-style M-1iA from FANUC or its six-axis LR Mate family. Assembling Medical Test kits, Assembly Inspection, packing, palletizing. Communicating Robots in a healthcare environment.

UNIT-IV

Human Machine Interferance –medical perspective,control of sensors in healcare robots;Workspace recognition ,Input-output of devices, machine human interaction, Guidelines for Human-Robot interference technology.Control architectures for Intelligent mobile robots, Concept of IMRs & IAS, Mobile robots kinematics & control, tackling control system for complexity, Global & local strategies for mobile robot navigation.State of Art on Manupulators

UNIT- V

Exoskeletons robotics in Actuated and sensory prostheses; rehabilitation of stroke, spinal cord injury patients, neurobehavioral or neuromuscular diseases such as multiple sclerosis. Robotics in in the recovery of people with disabilities, including improved mobility, strength, coordination, and quality of life. Pharmabotics: Preparation of patient specific medicines, sterilization, Supply of medicine to ICU, Preparation of IV solutions in hospital pharmacies,

Text Books:

1. Medical Robotics **Editors:** Achim Schweikard , & Floris Ernst
2. Medical Robotics, 1st Edition, Minimally Invasive Surgery

Reference Books:

Mobile Robotics in health care, Editor- Nikos Katevas Zenonsa, Athens, Greccece IOS press, Amsterdum.

https://www.roboticstomorrow.com/article/2018/05/advancement-of-robots-in-medicine/11948/

https://interestingengineering.com/15-medical-robots-that-are-changing-the-world

Course Outcomes

After learning the course, the students should be able to:

- To recognize the impact of materials selection on manufacturing and medical device reprocessing
- To apply fundamental engineering design principles to problems related to medical device design for reprocessing.
- To analyze manufacturing processes used in medical device reprocessing as related to testing, verification and validation processes.
- To design an example manufacturing process for a reusable medical device
- With the skills of various materials and designing of the medical device's students will get a unique understanding of the engineering approach towards the devices designa dn manufacturing with respect to the medical field.
- With these skills the students are highly qualified in getting the jobs in the medical and pharma manufacturing and R&D industries.

Course No: **MEC415**	Course Title: **Tissue Modeling**	L	P	U
		3	0	3

Course Learning Objectives

- To study the fundamental tools and techniques used in tissue engineering.
- To understand the fundamental knowledge about cell mechanics and its effect.
- To learn the basic concepts of biomaterial design and its application for the engineered tissues.
- To apply engineering principles in designing and modeling of hard tissues for biomedical applications.
- To apply basic concepts in modeling of the soft tissues for biomedical applications.

Course Contents

UNIT-I

Fundamental of Tissue Engineering**:** Basic definition, Specific tissue types, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, current scope of development and use in therapeutic and in-vitro testing.

UNIT-II

Cellular Studies: Cell culture, Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, cell storage and cell characterization. Molecular biology aspects: Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

UNIT-III

Biomaterial and Scaffolds**:** Introduction to Biomaterials, structure, properties, Criteria of modifying biomaterials as tissue engineering scaffolds, Properties and types of scaffolds, Different methods employed in the synthesis of scaffolds, animal cell biology, stem cells, organization of cells into tissues, tissue microenvironment, tissue injury and wound healing 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver.

UNIT-IV

Modeling of Hard Tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy.

UNIT-V

Modeling of Soft Tissues: Structure and functions of Soft Tissues- Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modeling of soft tissues: Cartilage, Tendon, Ligament, and Muscle, Hills's muscle model.

Text Books:

1. Principles of tissue engineering, Robert. P. Lanza, Robert Langer & Joseph Vacanti, 4th edition, 2014.
2. The Biomedical Engineering Handbook, Joseph D, Bronzino, CRC Press, 3rd edition, 2006.

Reference Books:

1. Biomaterials Science and Engineering, PARK J.B., Plenum Press, 1984.
2. Tissue Engineering – Engineering principles for design of replacement organs and tissue, W. Mark Saltzman, Oxford University Press Inc New York 2004.
3. Tissue Engineering, Bernhard Palsson, S. Bhatia , Pearson Prentice Hall, 2003

Course Outcomes

After learning the course the students should be able to:

- Build on a basic understanding of tissue engineering to develop a more in-depth level of understanding that will enable engineering analysis of selected biomedical systems.
- Be able to apply engineering principles in designing tissue for biomedical problems.
- Be able to translate the understanding of thermophysical properties function of materials into a tissue engineering model based on analysis of a biomedical system.
- Diversified approach of multidisciplinary skills for the students helps to get employable into the fields of Biomedical and Biotechnology.

Course No: **MEC416**	Course Title: **Medical Image Processing**	L	P	U
		3	0	3

Course Learning Objectives

- To learn the image fundamentals and mathematical transforms necessary for image processing
- To study the various image enhancement techniques
- To apply various image restoration procedures in Medical images.
- To gain knowledge about the basic concepts of image compression procedures.
- To study about the various segmentation techniques applied to Medical Images.

Course Contents

UNIT-I

Fundamentals of Digital Image and Transforms

Elements of Visual perception, Image sampling and quantization, Neighborhood pixel Relationships – Basic Image operations – Arithmetic, Geometric and Morphological,Image transform: 2D DFT-Discrete cosine-, Sine-, Haar-, and Hadamard- transform.

UNIT-II

Image Enhancement

Basic gray level transformation, Histogram processing ,Smoothening by spatial filters- Sharpening by spatial filters ,Smoothening- frequency domain filters, Sharpening-frequency domain filters ,Color image Processing- color models- Pseudo color image processing– Color Image Transformation.

UNIT-III

Image Segmentation

Edge detection- Marr Hidreth edge detector - Canny edge detector, Thresholding foundation -Basic global thresholding - Basic Adaptive thresholding, Region Based segmentation, Watershed segmentation algorithm.

UNIT-IV

Image Compression

Image compression- Fundamentals - Image compression standards- Coding: Run length-, Huffman-Arithmetic-, Bit plane-, Transform- and Lossy- and lossless-predictive coding.

UNIT-V

Image Restoration and Reconstruction of Medical Images

Image degradation models, Algebraic approach to restoration, inverse filtering, least mean square filter, Image reconstruction from projections - Radon transforms – Filter back projection algorithm – Fourier reconstruction of MRI Images

Text Books:

3. Rafael C., Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education Asia, Third Edition, 2007.
4. Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 2nd edition 1997.

Reference Books:

9. William K. Pratt, "Digital Image Processing", John Wiley, NJ, 4th Edition, 2007.
10. Albert Macouski, "Medical Imaging systems", Prentice Hall, New Jersey 2nd edition 1997.

Course Outcomes

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

- Will get the clear domain knowledge in understanding the various Medical Imaging techniques and its diagnostic applications.
- Gain critical insight into challenges underpinning image analysis, including image enhancement & compensating for artefacts.
- Develop specialized skills to interpret medical images critically & to communicate the findings to a range of audiences.
- Demonstrate subject specific knowledge & understanding in theoretical & practical aspects of medical image analysis & processing.
- With the skills of image processing and techniques in the contents helps the students to widen their areas of research into various diagnostics approaches and impart their understanding in improving the techniques.
- Employability chances are very high as the skills developed are high in demand of the skilled people.

Course No: **MEC417**	Course Title: **Cognitive Robotics**	L	P	U
		3	0	3

Course Learning Objectives

- Understand the cognition in the field of artificial intelligence.
- Discusses about fascinating discourse on negligence and product liability, as well as sections on whether to blame the robot or the human developer when an issue arises.
- Investigate cognitive robots and their interaction with elements of philosophy, chemicals, physical science, culture and society, psychology, and general artificial intelligence.

Course Contents

UNIT-I

Ethical Aspect of Cognitive Robotics: Introduction, When Robots Do Wrong, Blame The Robot? Blaming Homo sapiens, Negligence and Product Liability Laws, Robot Cars, Insurance.

UNIT-II

Philosophical Aspect of Cognitive Robotics: Designing Modular AI Robots Inspired by Amerindian Material Culture, Evolution of Technology and Ideas, The Amerindian World and The Techno–Animistic Paradigm Shift, Animism: Material and Metamorphosis, Egalitarian Societies, Formation Of A Robotic Community.Chemical Aspect of Cognitive Robotics: Perspective, The Second Law, Control of Fire, Emergence of Learning, Of Men And Centaurs, Great Escape

UNIT-III

Physical Aspect of Cognitive Robotics: Embodiment in Cognitive Robotics: An Update, Talking Chinese, Meaning And Recent Theoretical Debate, Recent Practical Implementations Of The Embodiment Of Emotions, Motivations And Intentional States

Imagined Physics: Exploring Examples of Shape-Changing Interfaces, Shape-Changing Interfaces, Shape-Changing Tumbling Objects: Bobles, Shape-Changing With Light, Shape-Changing Surfaces, Imagined Physics, Movement and Incidental Effects Of Actuators

UNIT-IV

Cultural & Social Aspects of Cognitive Robotics: Effects of Cultural Context and Social Role on Human–Robot Interaction, A Cognitive Model for Human Willingness to Collaborate with Robots, Social Cognition of Robots during Interacting with Humans,

Psychological Aspect of Cognitive Robotics: On the Crossroads of Cognitive Psychology And Cognitive Robotics, Action Control: Feedforward And Feedback Control In Humans, Feedforward And Feedback Control In Robots, Robotic Action Planning. Acquisition of Action Control: Human Action–Effect Learning, Traditional Action–Effect Learning. Research: Motor Babbling, Robotic Action–Effect Learning, Directions For The Future: Affordance Learning, Everyday Action Planning

UNIT- V

Artificial Intelligence Aspect of Cognitive Robotics: A Bottom-Up Integration Of Vision and Actions To Create Cognitive Humanoids, A Cognitive Robotics Approach, Perceiving The Environment-Object Detection: Icvision & Cgp-Ip, Interacting With The Environment, Collision Avoidance And World Model: Mobee, Action Repertoire: Trm & Leograsper: Closing the Action-Perception Loop

Text Books:

1. Hooman Samani , *Cognitive Robotics*, Taylor & Francis, New York, 2016.

Reference Books:

1. Ronald Brachman and Hector J. Levesque, *Knowledge Representation and Reasoning*, Morgan Kaufmann, 2004.
2. Raymond Reiter, *Knowledge in Action: Logical Foundations for Specifying and Implementing Dynamical Systems*. MIT Press, 2001.

Course Outcomes

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

- Understand cognative robotics
- Human machine cognative system
- AI approach into the Robotics will helps the students to update their skills into the area of Cognitive Robotics.
- Employable aspects are very high with respect to human robot interactions through this course are highly anticipated.

Course No: **MEC418**	Course Title: **Surgical Robots**	L	P	U
		3	0	3

Course Learning Objectives

- Identify and describe different types of medical robots and their potential applications.
- To know basic concepts in kinematics, dynamics, and control relevant to medical robotics.
- To develop the skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions.
- To understand the various roles that robotics can play in healthcare.
- To know the state of the art in applied medical robotics and medical robotics research.

Course Contents

UNIT-I

Introductory topics: Introduction to medical robotics (applications and paradigms). Basic kinematics concepts (forward, inverse, remote center of motion). Basic control concepts (impedance, admittance). Surgery for engineers. Interventional radiology for engineers.

UNIT-II

Minimally Invasive Surgery (MIS): Human-machine interfaces. Teleoperation. Cooperative manipulation. Port placement for MIS. Robot design concepts. Video images in MIS. Augmented reality. Minimally invasive surgery training.

UNIT-III

Robotic surgery systems: Supervisory-controlled systems, tele surgical systems and shared-control systems. Da Vinci Surgical System. ZEUS Robotic Surgical System. AESOP Robotic System.

UNIT-IV

Image-Guided Interventions: Medical imaging modalities (e.g., MRI, US, X-ray, CT). Robot compatibility with medical imagers. Image segmentation and modeling. Tracking devices. Frames and transformations. Surgical navigation Calibration. Rigid and non-rigid registration
Radiosurgery.

UNIT- V

Current topics in medical robotics: Existing clinical applications, controversies, and outcomes. Research topics: Mobile robots in the body, Instrument-tissue interaction modeling, Autonomous robotic surgery. Other types of healthcare robots: Physically assistive robotics, socially assistive robotics, Rehabilitation robotics.

Text Books / papers:

1. A. J. Madhani, G. Niemeyer, and J. K. Salisbury, Jr. The Black Falcon: a teleoperated surgical instrument for minimally invasive surgery. In Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems, pp. 936-944, 1998.

2. R. H. Taylor and D. Stoianovici. Medical Robotics in Computer-Integrated Surgery. IEEE Transactions on Robotics, 19(5):765-781, 2003.

3. J. Marescaux, J. Leroy, M. Gagner, F. Rubino, D. Mutter, M. Vix, S. E. Butner, M. K. Smith. Transatlantic Robot-Assisted Telesurgery. Nature, 413:379-380, 2001.

4. G. Fichtinger, P. Kazanzides, A. M. Okamura, G. D. Hager, L. L. Whitcomb, and R. H. Taylor. Surgical and Interventional Robotics Part II: Surgical CAD-CAM Systems. IEEE Robotics and Automation Magazine, 15(3):94-102, 2008.

5. A. L. Trejos, R. V. Patel, I. Ross, and B. Kiaii. Optimizing port placement for robot-assisted minimally invasive cardiac surgery. The International Journal of Medical Robotics and Computer Assisted Surgery, 3(4):355-364, 2007

Further References:

1. S. M. Farritor, A. C. Lehman, and D. Oleynikov. Miniature In Vivo Robots for Notes. In J. Rosen, B. Hannaford, and R. Satava, Eds., Surgical Robotics - Systems, Applications, and Visions, pp. 123-138. Springer, 2011.

2. H. Choset, M. Zenati, T. Ota, A. Degani, D. Schwartzman. Enabling Medical Robotics for the Next Generation of Minimally Invasive Procedures: Minimally Invasive Cardiac Surgery with Single Port Access. In J. Rosen, B. Hannaford, and R. Satava, Eds., Surgical Robotics - Systems, Applications, and Visions, pp. 257-270. Springer, 2011.

3. G. S. Guthart and J. K. Salisbury, Jr. The IntuitiveTM telesurgery system: overview and application. In Proceedings of the IEEE International Conference on Robotics and Automation, pp. 618-621, 2000.

Course Outcomes

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

- Identify and describe different types of medical robots and their potential applications.
- Understand the various roles that robotics can play in healthcare.
- Design and implement robotic assistance for both minimally invasive surgery and image-guided interventions.
- Advanced skills pertaining to robotics helps the students to get employeed into the various medical robots manufacturing and development industries.

Course No: **ME419**	Course Title: **Machine Perception**	L	P	U
		3	0	3

Course Learning Objectives

- To educate students in design and development of machine perception system for industrial applications.
- To understand the various hardware components of machine perception system.
- To build Machine-learning algorithms for input recognition, computer vision and image classification.
- To design automatically find, segment and track objects in scenes, perform face recognition and build three-dimensional models from images.

Course Contents

UNIT-I

Introduction, definition, human visual system, Active vision system, machine perception & its components and Computer Vision – HMI. Competing technologies, principle, MVS camera -Analog, Digital, Camera Calibration - Frame Grabber, Manual & Auto shutter and data capture. Triangulation geometry, resolution, passive and active 3-D stereo imaging, data processing.

UNIT-II

Fundamentals of Digital Image- Image classification, Inpt recognition, Filtering technique-Processing of binary and grey scale images-segmentation-thresholding-connectivity-noise reduction-edge detection-region growing and region splitting - binary and gray morphology operations.

UNIT-III

Conventional Newral networks, recurrent newral network-LSTM, GRU, Backpropogation through time, segmentation, generative adversarial networks, single perception, multilayer perception, tensor board

UNIT-IV

Logic, Inference, Ontology, Automated Planning and Acting, Uncertainty, Graphical Models, and Probabilistic Reasoning, Temporal Probabilistic Reasoning and Dynamic Bayesian Networks, Complex Decision-Making, Template Matching -Decision Making, 3D Machine Perception Techniques

UNIT- V

Applications of machine perception in Automotive Industries, Manufacturing, Electronics, Printing, Pharmaceutical, Biomedical, Robotics, Agricultural Industries.

Text Books:

2 E. R. Davies, Machine Vision: Theory, Algorithms, Practicalities, Academic Press, 2014.

Reference Books:

3. Alexander Hornberg, Handbook on Machine Vision, Wiley, 2006.
4. Herbert Freeman, Machine Vision: Algorithms, Architectures and Systems, Academic Press, 2012.
3. Computer Vision: Algorithms and Applications by Richard Szeliski (optional)
4. Russell, S. J. and Norvig, P. (2010). Artificial intelligence: A modern approach (3rd edition). Prentice-Hall.
5. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing Analysis and machine Vision, Cengage Learning, 2014.

Course Outcomes

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

- Understand and apply a series of probabilistic models of images and objects in machine perception systems.
- Understand the principles behind face recognition, segmentation, image parsing, super-resolution, object recognition, tracking and 3D model building.
- Skills of apply these machine perception concepts to electronic, manufacturing, automobile, pharmacy and packaging industries.
- Unified approach of the course content helps the students to get employable in the above mentioned industries.

Course No: **MEC421**	Course Title: **NANO ELECTRO MECHANICAL SYSTEMS**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

- To understand and apply basic principles of nano-technology
- To design and optimize the nano and microstructures
- To model the micro and nano scale systems and devices
- To understand and design carbon based nano electronic systems

Course Contents

UNIT-I

INTRODUCTION TO NANOTECHNOLOGY AND MICROTECHNOLOGY

Introduction and Overview: From Micro- to Nano- and Beyond to Stringo-Scale, Introductory Definitions to the Subjects. Current Developments and Needs for Coherent Revolutionary Developments, Societal Challenges and Implications.

UNIT-II

NANO- AND MICROSCALE SYSTEMS, DEVICES, AND STRUCTURES

Sizing Features: From Micro- to Nano-, and from Nano- to Stringo-Scale MEMS and NEMS Definitions. Introduction to Taxonomy of Nano- and Microsystem Synthesis and Design.
Introduction to Design and Optimization of Nano- and Microsystems in the Behavioral Domain.

UNIT-III

MODELING OF MICRO- AND NANOSCALE ELECTROMECHANICAL SYSTEMS AND DEVICES

Introduction to Modeling, Analysis, and Simulation, Basic Electromagnetics with Applications to MEMS and NEMS, Model Developments of Micro- and Nanoactuators Using Electromagnetics, Classical Mechanics and Its Application to MEMS, Equations of Motions, Direct-Current Micromachines, Simulation of MEMS in the MATLAB Environment with Examples, Induction Micromachines

UNIT-IV

QUANTUM MECHANICS AND ITS APPLICATIONS

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics, Quantum Mechanics and Energy Bands

MOLECULAR AND CARBON NANOELECTRONICS

Past, Current, and Future of Electronics with Prospects for 2020 and Beyond, Fundamentals, Carbon Nanotubes, Carbon-Based Nano electronics and Three-Dimensional Nano-ICs.

UNIT- V

NEMS AND NANOSYSTEMS

Introduction, components, products of Nano systems-Nanoactuators-Bio sensors, Molecular motors, Nanomanipulation- Nano assembly, self assembly- Nano imprint fabrication-Nano thermal sensors, Actuation using piezo electric and shape memory alloys-Electrostatic and CNT actuators. Applications of Nanofluid in Nanomachining.

Text Books:

1. Sergey Edward Lyshevski, Lyshevski Edward Lyshevski, "Micro-Electro Mechanical and Nano-Electro Mechanical Systems, Fundamental of Nano and Micro-Engineering", CRC Press, 2005.
2. Principles and Applications of Nano-MEMS Physics, H. J. Delos Santos, Springer, 2008.
3. Pelesko J. A. and D. H. Bernstein, "Modeling MEMS and NEMS". Chapman & Hall/ CRC, 2002.

Reference Books:

1. Encyclopedia of Nanoscience and Technology, Vol. 5, H. S. Nalwa (ed.), American scientific Publishers, 2004
2. Carbon Nanotubes and Related Structures, P. J. F. Harris, Cambridge University Press, UK, 1986.
3. Carbon Nanoforms and Applications, M Sharon and M. Sharon, Mc Graw Hill, 2010
4. Quantum Phenomena, S. Datta, Addison – Wesley, 1989.

Cao.G, "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", Imperial College Press, 2004.

Course Outcomes

After the completion of this course the student will be able to;

- Understand the basic concepts and principles of nano technology
- Understand the physics and chemical concepts useful for developing NEMS systems
- Apply the principles for the design and optimize the nano and microstructures
- Assess the micro and nano scale systems and devices through modeling
- Design and develop carbon based nano electronic systems.
- Skills of both Mechanical and Electronics at nanoi level are developed by the students after completion fo the course.
- With these skills the students are highly employable in the area of Mechatronics Industries.

Course No: **MEC422**	Course Title: **Smart Materials**	L	P	U
		3	0	3

Course Learning Objectives

- To understand the fundamental concepts of smart materials and structures.
- To understand the many types of smart materials like shape memory alloys, piezoelectric, magnetostrictive, magnetorheological fluids, electrorheological materials.
- To understand the Mathematical Modelling of Piezoelectric Bodies.
- To understand the Actuation and Sensing Mechanisms.
- To understand Shape Memory Alloy Materials, MR Fluids and Active Composites
- Apply these fundamental concepts to the modeling, analysis, and control of Smart Structures in Engineering Practice.

Course Contents

UNIT-I

Introduction to Smart Structures:

Definition and Main Constituents of Smart Structures and Traditional Structures, Smart Structures and Active Materials, The Physical Behaviour of Active Materials for Actuation and Sensing, Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Electrorheological materials, Magnetorheological fluids, Shape Memory Alloys, Motivations for the Use of Smart Structure Technologies.

UNIT-II

Mathematical Modelling of Piezoelectric Bodies:

Analysis of Piezoelectric Continua, Constitutive Relations of Piezoelectric Materials, Energy Coupling Coefficients, The Equations of Linear Piezoelectricity for a Three-dimensional Continuum, Energy Considerations, Governing Equations in Terms of Displacements and Electric Potential, Analysis of a Two-dimensional Piezoelectric Continuum under Electrical and Mechanical Loading, The Case of Linear Constitutive Relations, The Case of Nonlinear Constitutive Relations.

UNIT-III

Actuation and Sensing Mechanisms:

The Induced Strain Actuation Mechanism, Axial Actuation, Static Actuation, Dynamic Actuation, Bending Actuation, The Thermocouple Analogy, Pure Bending Induced by Patched Actuators, Pure Axial Extension Induced by Patched Actuators, The Pin-force Model, The Generalization of Pin-force and Euler–Bernoulli Beam Actuation, Pin-force Model, Euler–Bernoulli Model, Static Response of a Beam Subjected to Bending Actuation, Dynamic Response of a Beam Actuated in Bending, Higher Order Models for Beam Bending Actuation, Single Layer Higher Order Model, Multilayer Higher Order Model, Equilibrium Equations, Sensing Mechanism, Control Issues.

UNIT-IV

Shape Memory Alloy Materials and MR Fluids:

Shape Memory Alloy Materials, Shape Memory Alloy Actuators, Control Design for Shape Memory Alloy Systems, Designing with MR Fluids, MR Fluid Valve Design and Magnetic Circuit Design, Applications of MR Fluids.

UNIT- V

Active Composites:

The Concept of Active Composites, Piezoelectric Fibre Composites, Interdigitated Electrodes for Piezoelectric Components, Micromechanics of a Piezoelectric Fibre Composite, Elastic Properties of a Fibre Composite, Dielectric Properties of a Fibre Composite, Macromechanics of Active Composites, Constitutive Relations of a Piezocomposite Lamina, Macromechanics, Application of Smart Structures in Engineering Practice

Text Books:

1. Smart Materials and Structures, Gandhi, M.V., Thompson, B.D., Springer, 1st Ed. 1992.
2. Smart Structures: Physical Behaviour, Mathematical Modelling and Applications, Paolo Gaudenzi, Wiley, 2009.
3. Smart Structures: Analysis and Design, Dr. A V Srinivasan, D Michael McFarland Cambridge University Press, 2000.

Reference Books:

1.Smart Composites: Mechanics and Design, Rani Elhajjar, Valeria La Saponara, Anastasia Muliana, CRC Press, 1st Ed. 2013.
2. Dynamics of Smart Systems and Structures: Concepts and Applications, Vicente Lopes Junior, Valder Steffen Jr., Marcelo Amorim Savi, Springer; 1st Ed. 2016.
3. Smart Materials, Mel Schwartz, CRC Press, 1st Ed. 2008.
4. Smart Material Systems and Mems: Design and Development Methodologies, Vijay K Varadan, K J Vinoy, S Gopalakrishnan, Wiley 2006.

Course Outcomes

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

- Have knowledge about of the smart materials.
- Selection of proper smart material for the proper engineering application.
- Able to design necessary smart structures to control the behavior of the structure.
- Able to use the Smart Structures and Intelligent System are becoming an integral part of new aerospace and automobile systems due to high performance and fast response potential.
- Knowledge in this field is multi-disciplinary in nature involving materials, composites, basic electronics, control system and informatics.
- Skills with multi-disciplinary study helps in getting high chance of employable in the areas of Material Science with deep approach towards the analysis and design of various material structures.

Course No: **MEC423**	Course Title: **CNC Technology**	L	P	U
		3	0	3

Course Learning Objectives

- To learn the automation in manufacturing.
- To learn the NC, CNC machine tools and its applications.
- To learn various components in NC, CNC machine tools.
- To learn the hardware and software configurations.
- To learn the NC, CNC machine tools programming.

Course Contents

UNIT-I

Introduction to Automation – Goals of Automation, levels of automation, Hard Vs Soft Automation, Computer Aided manufacturing (CAM). Numerical Control - Introduction, Role of NC / CNC in CAM, Applications of NC / CNC, Benefits of NC / CNC, Limitations of CNC.

UNIT-II

Basic Components of CNC system – Part programming, Machine control unit, Machine tool - Historical developments and their role in control of machine tools, Classification of NC / CNC systems - Based on type of Control (PTP\C\L), method of programming, type of architecture - Hardware / Software / Open source softwares.
Machine Control Unit - Data processing Unit - elements and their functions - Interpolators and Sequential Controllers.

UNIT-III

Interpolators - Types and Stages of Interpolation, Principles of interpolation - Techniques employed for Interpolation Scheme, Requirements of Interpolation algorithms, Interpolation schemes – Stairs approximation, Digital Differential Analyser, Direct function calculation; DDA - Hardware and Software; Software Interpolators.
Sequential controllers - Concepts, Relay ladder diagrams and their development.

UNIT-IV

Programmable Logic Controllers - Elements of Hardware and Software, Methods of programming - Ladder Logic Programmes (LAD), Function Chart (FC), Statement List (STL) - Program scanning and its execution
Programming with Basic functions - Internal Relays, Timers, and Counters - different types and programming examples - Advanced functions and their applications

UNIT- V

Part programming - Introduction; Part Program and its elements, Methods of Programming - Manual and Computer Assisted Part programming - Custom Macro (Parametric Programming), APT and its variations, Concepts of CAM - Tool path generation and control methods.
Machine Tool - Components of CNC machine tool, Drives and controls, Automatic Tool Changers, Automatic Pallet Changers, tool offsets and work offsets, high speed and precision machining concepts

Text Books:

1. Koren Y, Computer Control of Manufacturing systems, McGraw Hill, 1986.
2. Reinbold U, Blume C and Dilmann R, Computer Integrated Mfg. Technology & Systems, Marcel Dekker, 1985.

Reference Books:

1. John W. – Programmable Controllers - Principles and Applications - Merrill Publ.Co, New York, 1980.
2. Madison J, CNC machining Handbook, Industrial Press Inc., 1996.
3. Barry Leatham - Jones, Introductions to Computer Numerical Control, Pitman, London - John willey & Sons, 1986.
4. Roger S. Pressman & John E. Williams, Numerical Control and Computer Aided Manufacturing, John Willey.

Course Outcomes:

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

- Apply the knowledge of automation process in various industries.
- Apply the advanced machine tools like NC, CNC in manufacturing process.
- Interpret software and hardware configurations in manufacturing process.
- Analyze the programming execution in electronic components.
- Write the programming for machine tools like NC, CNC.
- With the skills of CNC technology the employability chances are very high with both simulation and practical understanding and experience of working.

Course No: **MEC424**	Course Title: **Computer Integrated Manufacturing**	L	P	U
		3	0	3

Course Learning Objectives: This course is designed to provide practical experience to the students with an opportunity of hands-on training on modern CNC machines and CIM system. Its objectives are

- to expose the student to the different types of manufacturing available today such as the Special manufacturing System, the Manufacturing Cell, and the Flexible Manufacturing System (FMS).
- to learn the fundamentals of computer assisted numerical control programming and programming languages,
- to learn the concepts of Computer Integrated Manufacturing and Management System and automated flow lines,
- to learn the guidelines and criteria for implementing CAD/CAM Systems and associated software for design, Manufacturing, and a common CAD/CAM data base organized to serve both design and manufacturing, and
- to discuss current research trends and possible future development.

COURSE CONTENTS

UNIT – I

Introduction: Automation, Need for Automation, Types of automation systems, Automation strategies, levels of automation, Introduction to NC, CNC and DNC and Computer integrated manufacturing, CIM wheel, components of CIM Part programming: Introduction, NC coordinate system, fixed and floating zero machines, NC motion control systems, part programming methods, Manual part programming for milling and lathe using G and M codes, various canned cycles.

UNIT – II

Group Technology: part families, part classification and coding, production flow analysis, composite part concept, benefits of GT. Flexible Manufacturing System: Definition of FMS, components of FMS, types of flexibilities, classification of FMS, primary and secondary material handling systems, FMS layout configurations, computer control system, FMS applications and benefits.

UNIT –III

Automated Material Handling and AS/RS: Introduction, types of material handling equipment, automated guided vehicle system (AGVs), applications, vehicle guidance and routing, traffic control and safety system management, Basic components of AS/RS, types of AS/RS, AS/RS controls, special features.

UNIT- IV

Robotics: Definition, robot anatomy and related attributes, robot configuration, work volume, types of control systems, end effectors, industrial applications of robot, introduction to robot programming. Automated Inspection & Testing: Automated inspection principles, off-line and on-line inspection, contact and noncontact inspection techniques, Co-ordinate measuring machine (CMM): Introduction and types of CMM.

UNIT- V

Manufacturing Support System: Product design and CAD, concurrent engineering and Computeraided process planning (CAPP).

Text Books:

6. "Automation, Production Systems and Computer-Integrated Manufacturing" by Mikell P Groover
7. "Computer Integrated Manufacturing: Current Status and Challenges" by Kiyoji Asai and I Burhan Turksen

Reference Books:

1. "Qualification for Computer-Integrated Manufacturing" by Felix Rauner
2. "Crossing the Border: The Social and Engineering Design of Computer Integrated Manufacturing Systems (Human-centred Systems)" by J Martin Corbett.
3. "Fundamentals of Production Planning and Control" by Stephen N Chapman
4. "Industrial Automated Systems: Instrumentation and Motion Control" by Terry L M Bartelt.
5. "Industrial Robot Handbook (VNR Competitive Manufacturing Series)" by Richard K Miller.
6. "Computer Automation in Manufacturing: An introduction" by Thomas O Boucher.

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

- Knowledge and operational experience of CNC lathe and milling part programming.
- Knowledge and operational experience of programming for robots and CMM Capability to comprehend the functioning of various components of the automation and CIM.

Course No: **MEC425**	Course Title: **Hydraulic and Pneumatic Systems**	L	P	U
		3	0	3

Course Learning Objectives:

The objective of this course is

- To learn of the fundamentals of fluid flow interaction with different objects
- Demonstrate knowledge of introductory concepts within pneumatic and hydraulic systems.
- Identify operational characteristics, component functions, and maintenance procedures of a hydraulic system.
- Understand the operating principles of a pneumatic system.
- Identify operational characteristics and service procedures applicable to heavy duty compressors.

Skill Development & Employability:

- Analyze fluid power components and circuits.
- Design and simulate fluid power circuits for any applications.
- Formulate and analyze models of hydraulic components and circuits; and how to
- Design and predict the performance of fluid power circuits.

Course Content

UNIT I FLUID POWER PRINCIPLES AND FUNDEMENTALS

Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids- Properties of fluids Basics of Hydraulics – Pascal's Law- Principles of flow – Work, Power and Torque. Properties of air– Perfect Gas Laws.

UNIT II HYDRAULIC SYSTEM AND COMPONENTS

Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps, Hydraulic Actuators: Cylinders – Types and construction, Hydraulic motors Control Components: Direction control, Flow control and Pressure control valves- Types, Construction and Operation- Applications – Types of actuation. Accessories: Reservoirs, Accumulators, Intensifiers, Pressure Switches- Applications- Fluid Power ANSI Symbol.

UNIT III HYDRAULIC CIRCUITS

Industrial hydraulic circuits- Regenerative, Pump Unloading, Double-pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-safe, Speed control, Hydrostatic transmission, Accumulators, Electro hydraulic circuits, Mechanical Hydraulic servo systems.

UNIT IV PNEUMATIC SYSTEM

Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Servo systems. Introduction to Fluidics, Pneumatic logic circuits.

UNIT V DESIGN OF HYDRALIC AND PNEMATIC CIRCUITS

Design of circuits using the components of hydraulic system for Drilling, Planning, Shaping, Punching, Press. –Selection, fault finding and maintenance of hydraulic components- Sequential

circuit design for simple application using cascade method, Electro pneumatic circuits. Selection criteria of pneumatic components Installation fault finding and maintenance of pneumatic components. Microprocessor and PLC- Applications in Hydraulic and Pneumatics- Low cost Automation Hydraulic and Pneumatic power packs

Text Books

1. Anthony Esposito," Fluid Power with Applications", PHI / Pearson Education, 2005.

Reference Books

1. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.
2. Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2001
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.
4. Micheal J, Pinches and Ashby, J.G., "Power Hydraulics", Prentice Hall, 1989.
5. Dudelyt, A Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987.

Course Outcomes

At the end of this course students will have reliably demonstrated knowledge of the following:

- Identify hydraulic and pneumatics components.
- Ability to design hydraulic and pneumatic circuits. Hydraulic Pumps
- After completion of the course the students will be upgraded with the skills to analyze fluid power components and circuits.
- With the compatibility of design and simulate fluid power circuits with various applications, the students get enough opportunities to get employable in area of Hydraulic and Pneumatic machines.

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.

REGISTRAR
THE ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deemed-to-be-University Under Section 3 of the UGC Act, 1956)

ICFAI FOUNDATION FOR HIGHER EDUCATION
HYDERABAD

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

IcfaiTech

Faculty of Science & Technology (FST

Contact
ICFAI Tech Hyderabad, IFHE Campus,
Donthanapally, Shankarapalli Road, Hyderabad - 501203, Telangana, India.