PROCEEDINGS OF THE FIRST

BOARD OF STUDIES

MEETING

OF THE

DEPARTMENT OF

MECHANICAL ENGINEERING

ISLAMIC UNIVERSITY OF SCIENCE AND TECHNOLOGY

AWANTIPORA, J&K, INDIA-192122

25TH AUGUST 2018

Contents

Agenda

1. **To discuss and finalize the course outline and detailed syllabus of first year B.Tech. Programme from 2018 Batch.**

   AICTE in their recent communication to all the Universities and Colleges has recommended to adopt the model curriculum devised for undergraduate courses (B.Tech.) which incorporates choice based credit system, a concept of electives (Professional/Open), mandatory internships, mandatory induction programme, lesser credit load, and incorporation of MOOCS courses in the curriculum. Besides AICTE has also strongly recommended to include an industry expert in the Board of Studies for suggestions in coherence with the human resource demand in the industry.
   Being a part of TEQIP-III Project Institutions, one of the mandates directed by MHRD/NPIU is to revise the curriculum of B.Tech Programme from Academic Session 2018 in accordance with the AICTE guidelines. In this regard, a series of meetings of the Heads/In-charge Heads of the Departments were held with the Dean, School of Engineering and Technology. A consensus on the course outline and syllabus for the first year B.Tech. Programme was reached (Annexure I).

   The proposed course outline and syllabus for first year B.Tech. Program needs to be discussed and approved formally.

2. **To discuss and finalize the course outline and detailed syllabus of 3rd to 8th Semester, B.Tech Mechanical Engineering Program from 2018 Batch.**

   The Department of Mechanical Engineering in a series of its Departmental Monitoring and Quality Assurance Meetings deliberated upon the contents and the detailed syllabus from 3rd to 8th semester of its B.Tech Program from 2018 Batch. Keeping into consideration the credit load desired in a semester as well as the Program completion requirements, the course outline and detailed syllabus from 3rd to 8th Semester is proposed (Annexure II).

   The proposed course outline and syllabus for B.Tech. Mechanical Engineering Program (3rd to 8th Semester) needs to be discussed and approved formally.

3. **To discuss and finalize the changes in the course outline and syllabus of 3rd Semester, 2017 Batch and 5th Semester, 2016 Batch.**

   Owing to the adoption of the revised curriculum in (2) above, the department suggests to adopt the similar curriculum for the existing batches of 2016 and 2017. In this regard, few changes in the course outline and syllabus of the 3rd semester, 2017 batch and 5th semester of 2016 batch are proposed (Annexure III). This is owing to the fact that few courses have already been taught or have not been taught at all in the new course outline at (2). With the above modification, the approved curriculum at (2) shall be applicable for 2016, and 2017 batches as well from the Spring 2019 session.

   The proposed course outline and syllabus for 3rd Semester, 2017 Batch and 5th Semester, 2016 Batch, of B.Tech. Mechanical Engineering Program needs to be discussed and approved formally.

4. **Any other agenda with the permission of the Chair.**

Minutes of the Meeting

The first Board of Studies (BoS) meeting of the Department of Mechanical Engineering (DoME), IUST was held on 25th August 2018. The following members attended the meeting:

1.	Prof. A. H. Moon	Dean SoE&T, IUST	Chairman
2.	Prof. P. M. V. Subbarao	Professor, ME, IIT Delhi	Subject Expert
3.	Mr. Zia Ashai	CEO SuperTherm, Srinagar	Industry Expert
4.	Dr. Majid Hameed Koul	I/C Head, DoME	Convener
5.	Dr. Azher Jameel	Assistant Professor, DoME	Member
6.	Ms. Mahvash Afzal	Assistant Professor, DoME	Member
7.	Mr. Ovais Gulzar	Assistant Professor, DoME	Member

Additionally, the following faculty members also attended the said meeting:

1. Mr. Umar Rashid, Assistant Professor, DoME
2. Mr. Mohit Teacher, Assistant Professor, DoME

At the outset, Dr. Majid H. Koul, I/C Head, Department of Mechanical Engineering presented a welcome note and briefed the members about the agenda of the meeting. The members were apprised about the recent decisions of the academic council of IUST which included formation of separate Board of Studies for the Departments, approval of Choice Based Credit System (CBCS) policy, inclusion of Massive Online Open Courses (MOOCS) in the curriculum, etc. The members were also briefed about the mandate under TEQIP-III project for up-gradation of the curriculum as per All India Council for Technical Education (AICTE) model curriculum and the conduct of BoS meeting thereby. I/C Head, DoME also highlighted the importance of designing the curriculum as per the present industry requirements. After threadbare discussions, the following decisions against the respective agenda points were made:

Agenda No. 1: To discuss and finalize the course outline and detailed syllabus of first year B.Tech. Programme from Batch 2018 onwards.

Decisions:

1. The subject expert recommended that the course "Engineering Graphics and Design", taught in the first semester of B.Tech Programme shall be owned by the Department of Mechanical Engineering. The course contents should be modified and updated as per the AICTE model curriculum 2018, which lays emphasis on the use of CAD tools.
2. Both the experts (Subject and Industry) were of the opinion that the courses "Environmental Science" and "Communication Skills" should be taught in the first semester only instead of the second semester of the B.Tech. Programme. The decision was very well acknowledged and accepted by all the board members. The course contents of the above courses were discussed and it was decided to include the lab content also in the communication skills course as suggested by AICTE.
3. It was decided that the foundation courses Physics and Chemistry (Theory) shall be taught in the first semester whereas the courses Physics lab and the Chemistry lab shall be taught in the second semester of the B.Tech. Programme.
4. The board recommended that the course "Engineering Mechanics" should be owned by the Department of Civil Engineering as the major portion of the syllabus includes Statics. However, contents viz. friction and dynamics (as suggested in AICTE Model Curriculum) may be taught by the faculty members from Department of Mechanical Engineering.
5. It was recommended that the course on "Basic Electrical Engineering" shall be taught in the second semester of the B.Tech. Programme.
6. The syllabus of "Workshop Practices" was discussed and it was decided to include the "Electrical & Electronics Shop" in the curriculum as suggested in the model curriculum of AICTE.

Agenda No. 2: To discuss and finalize the course outline and detailed syllabus of 3rd to 8th Semester, B.Tech Mechanical Engineering Program from Batch 2018 onwards.

Decisions:

1. It was recommended that the course title for "Manufacturing Technology" be changed to "Machining Processes", as most of the course content was related to metal cutting processes only. Consequently, the course title for "Manufacturing Technology Lab" be also changed to "Machining Processes Lab".

2. It was recommended that the course title for "Laplace, Fourier Transform and Complex Analysis" be changed to "Applied Mathematics for Engineers".

3. The experts recommended that "Fluid Mechanics", being a very basic course, shall be taught in the 3rd semester only. Consequently, the course on "Basic Electronics Engineering", shall be taught in the 4th semester.

4. The syllabus for the course in "Basic Electronics Engineering" was discussed and the committee members were of the opinion that the course contents need to be revised. It was recommended that revised syllabus should be devised in consultation with the Department of Electronics and Communication Engineering.

5. A consensus was reached to combine the course contents of "Fluid Mechanics Lab" and "Applied Thermodynamics Lab" into "Thermo-Fluids Lab", keeping in view the optimum utilization of time and resources. The syllabus of the course "Thermo-Fluids Lab" shall be accordingly updated.

6. It was decided to include the course "Electrical and Electronics Lab" in the 4th semester of the curriculum. This would provide exposure to the students with basic and advanced electrical and electronic technologies. The list of experiments should be finalized in consultation with the Departments of Electrical Engineering and Electronics and Communication Engineering.

7. The subject expert suggested to include a topic on "Sensors" in the "Measurement and Instrumentation" course. However, the committee was informed that a course on "Mechatronics" is already in the offing in the subsequent semester and the topic is included in its syllabus. The subject expert further suggested to add "Experimental Methods for Engineers" by J. P. Holman in the list of reference books for the "Measurement and Instrumentation" course.

8. The committee recommended to combine the course contents of the course "Theory of Machines Lab" and "Mechanical Vibrations Lab" into a single lab course namely "Mechanisms and Vibrations Lab". The list of experiments shall accordingly be revised and updated.
9. It was recommended to introduce a course on "Microcontrollers" in the 5th semester of the curriculum. The same would cater to the interdisciplinary demand and contemporary applications of the course in Mechanical Engineering. The syllabus for the same shall be finalized in consultation with the Department of Electronics and Communication Engineering. Consequently, the Chairman BoS recommended to delete the course on "Industrial Electronics", proposed in the old curriculum.
10. The syllabus of the course on "Advanced Manufacturing Processes" was discussed and it was decided to delete the section on "Metrology and Inspection" from the same. Instead, a unit on "Rapid Prototyping and Rapid Manufacturing" should be added to the course.
11. It was suggested to float a separate course on "Metrology and Inspection" as a departmental elective.
12. Expert from the industry recommended to include an elective course on "Industrial Automation" which shall broadly include topics like PLC Programming, Ladder Logic, SCADA, etc. The subject expert suggested to devise the syllabus for the course in consultation with the similar course offered at IIT Delhi.
13. A unit on "Introduction to Noise" was recommended to be included in the syllabus of the course "Mechanical Vibrations".
14. Topics related to "Compressors" were deleted from the course on "Hydraulics and Hydraulic Machines", as they were already covered in the course contents of the previous semester. In turn, a topic on "Hydraulic Lifts" was recommended to be added to the course contents.
15. Lab course on "Hydraulic Machines Lab" was renamed to "Fluid Machines Lab" and few experiments on single-stage and multi-stage compressors were recommended to be added to it.
16. It was recommended to include a course on "Operations Research" in the curriculum of 8th semester and one departmental elective only, in addition to the major project.
17. It was recommended to classify the electives courses into three categories, viz. 1) Departmental Level Electives, offered to the students of parent department, i.e., Mechanical Engineering; 2)

School Level Electives, offered to the students of parent department and to students of other departments of engineering; 3) Open Electives, offered in general to the students of the University, but not to the students of parent department. The committee was informed that Academic Council of IUST had recently approved similar categories for the electives, but with a different nomenclature, viz. Discipline Centric Electives, Generic Electives and Open Electives, respectively. The committee recommended to adopt the nomenclature approved by the academic council, IUST.

18. It was further agreed that the credit requirements for open electives shall be as per the CBCS policy of IUST which recommends completion of at least 8 credits of open electives courses during the B.Tech Programme. It was however recommended that the students shall be allowed to register for the same from 4th semester onwards till the 8th semester of the B.Tech Programme.

19. In conformity with AICTE recommendations, it was recommended that the credit requirements for Discipline Centric Electives would be a minimum of 9 credits and for Generic Electives, a minimum of 6 credits. The same would thereby lead to a minimum of 166 credits to be earned for completion of a B.Tech. Programme in Mechanical Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits, which may be acquired through MOOCs.

Agenda No. 3: To discuss and finalize the changes in the course outline and syllabus of 3rd Semester, 2017 Batch and 5th Semester, 2016 Batch.

Decisions with respect to Syllabus of B. Tech, Batch 2017 (3rd Semester Onwards)

1. In order to benefit students of Batch 2017 with the new curriculum, the board recommended to adopt the 'new curriculum from 3rd semester onwards' for the Batch 2017 with minor changes.
2. The following changes were thereby approved:
    i) The course on "Basic Electronics Engineering" in the 4th semester of the new curriculum shall be replaced by a course on "Fundamental Dynamics" as the Batch 2017 students have not studied dynamics in their second semester. The syllabus for Fundamental Dynamics was discussed and consequently approved.
    ii) The minimum number of credits to be completed by the students of Batch 2017-21 is 185 as per the IUST statues. Keeping the minimum requirement of credits for the B.Tech. Programme into consideration, it was recommended to increase the number of credits for Project-I, Project-II, Minor Project and Major Project in the new curriculum appropriately for Batch 2017.

Decisions with respect to Syllabus of B. Tech, Batch 2016 (5th Semester Onwards)

1. The department since its inception in 2016 had framed the syllabus up to 4th semester only. The board members therefore recommended to adopt the 'new curriculum from 5th semester onwards' for the Batch 2016 also with minor changes.
2. The following changes were thereby approved:
    i) The course on "Manufacturing Processes Lab" shall be replaced with a course on "Applied Thermodynamics Lab" in the 5th semester course curriculum of Batch 2016, as the students have already studied Manufacturing Processes Lab in the previous semester.
    ii) Also, the course on "Manufacturing Processes" has already been studied by students of Batch 2016, therefore the same shall be deleted from the revised curriculum of this batch in their 5th semester.

iii) Keeping the minimum requirement of credits for the B.Tech. Programme into consideration (185 as per the IUST statues), it was also recommended to increase the number of credits for Project-I, Project-II, Minor Project and Major Project in the new curriculum appropriately for Batch 2016 also.

In addition to the above decisions, the following suggestion were also put forth by the experts:

1. A basic course in mechanical engineering may be floated as an open elective for other departments.
2. Numerical Methods shall be floated as a Mechanical Engineering course with the departmental course code.
3. Advanced topics may be added in the syllabus (wherever feasible) to ignite the student's interest in the subject.
4. The instructor's in-charge of core labs may prepare lab hand-outs.
5. Text books for each subject shall be separately mentioned, so that the student has a clear idea of the text book being followed by the course instructor.
6. Project-I, II shall be devised to include: Problem Finding, Conceptualization, Planning, and Implementation. Such projects may be facilitated via hobby clubs or through Innovation Centers viz. DIC, etc.
7. Project II may be taken up as winter internship. It shall be evaluated in the sixth semester.
8. To assess the number of students interested in a course, a concept of pre-registration may be introduced. The process can be initiated before the end-semester exams of the previous semester.
9. GATE counseling should be initiated inviting professors from IIT's to motivate the students and inform them of the paper pattern, preparation strategies, etc.

The meeting concluded with a vote of thanks by Prof. A. H. Moon, Dean, School of Engineering and Technology, IUST.

Members of the Board of Studies, Department of Mechanical Engineering, IUST, JK

Mr. Ovais Gulzar, AP
Member

Ms. Mahvash Afzal, AP
Member

Dr. Azher Jameel, AP
Member

Dr. Majid Hameed Koul, I/C Head, DoME
Convener

Mr. Zia Ashai, CEO SuperTherm
Industry Expert

Prof. P. M. V. Subbarao, IIT Delhi
Subject Expert

Prof. A. H. Moon
Dean SoE&T, IUST
Chairman, BoS, ME

Enclosed: Final Approved Course Outline and Syllabus as per Agenda (As Annexures I to VII)

Annexure I
Credit definition, range, distribution, and Course codes

A. Definition of Credit:

1 hr. Lecture (L) per week	1 credit
1 hr. Tutorial (T) per week	1 credit
1 hr. Practical (P) per week	0.5 credit
2 hrs. Practical (P) per week	1 credit

B. Range of Credits:

Credits earned in the range of 166 and above shall be required for a student to be eligible to get Under Graduate Degree in Mechanical Engineering. A student will be eligible to get Under Graduate Degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits. These could also be acquired through MOOCs.

C. Distribution of Credits

S. No.	*Category*	*Credit Breakup*
1.	Humanities and Social Science including Management Courses	6
2.	Basic Science Courses	29
3.	Engineering Science Courses	23
4.	Professional Core Courses	69
5.	Discipline Centric Electives	9
6.	Generic Electives	6 (min)
7.	Open Electives	8 (min)
8.	Project / Seminar / Internship in Industry or Elsewhere	16
Total		166 (min)

D. Course Code and Definition:

All courses (except Open Electives) are denoted by a seven digit alphanumeric code (XXXXXXX), three alphabets followed by three numerals, followed by one alphabet.

1. The first three alphabets designate the department teaching the course, i.e., the discipline to which the course belongs, e.g., MEC for Mechanical Engineering.
2. The first numeral following the three alphabets indicate the level of the course, 1 to 4 for undergraduate 1st to 4th year; 5 to 7 for postgraduate 1st to 3rd year, and 8, 9 for PhD.
3. The next two numerals are the unique identification numbers for the course. Courses running in odd semesters are labelled from 01 to 49 and courses running in even semesters are labelled from 50 to 99.
4. The last alphabet indicates the nature of the course. It is one amongst four choices, C (Core Course), E (Elective (Discipline Centric)), G (Elective (Generic)), F (Foundation Course).
5. Open Electives have a zero in place of the above level numeral and thereby six digits only.

Annexure II

Vetted Course Outline and Syllabus for B. Tech. (First Year), 2018 Onwards

Semester-I

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	PHY101C	Physics	**4**	**0**	**0**	**4**	**4**
2.	CHM101C	Chemistry	**4**	**0**	**0**	**4**	**4**
3.	MTH103C	Mathematics-I	**3**	**0**	**0**	**3**	**3**
4.	BIO101F	Environmental Science	**3**	**0**	**0**	**3**	**3**
5.	MEC101C	Engineering Graphics and Design	**1**	**0**	**4**	**5**	**3**
6.	ENG101F	Communication Skills	**2**	**0**	**2**	**4**	**3**
7.	-	Induction Programme	**-**	**-**	**-**	**-**	**-**
Total Credits							**20**

Semester-II

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	CIV150C	Engineering Mechanics	**3**	**0**	**0**	**3**	**3**
2.	MTH153C	Mathematics–II	**4**	**0**	**0**	**4**	**4**
3.	CSE150F	Programming for Problem Solving	**3**	**0**	**0**	**3**	**3**
4.	MEC150C	Workshop Practices	**1**	**0**	**4**	**5**	**3**
5.	ELE150C	Basic Electrical Engineering	**3**	**0**	**0**	**3**	**3**
6.	CSE151F	Programming Lab	**0**	**0**	**2**	**2**	**1**
7.	PHY150C	Physics Lab	**0**	**0**	**2**	**2**	**1**
8.	CHM150C	Chemistry Lab	**0**	**0**	**2**	**2**	**1**
Total Credits							**19**

PHY101C **Physics** **4-0-0**

Vectors: Vector Analysis, Rotation of coordinate axis and Transformation of vectors, Gradient of scalar field, divergence and curl of vector field in Cartesians, Spherical polar and Cylindrical Coordinate systems, line , surface & volume integrals, Gauss's divergence theorem, Stokes's theorem.

Mechanics: Newton's laws of motion**,** rigid body, centre of mass, conservation of linear momentum, moment of inertia, conservation of angular momentum, Central forces, Keplers laws for planetary motion.
SHM, Damped, undamped and forced Oscillations (no derivation): Equation of motion, solution, amplitude resonance, velocity resonance, quality factor.

Special theory of Relativity: Frame of reference, Michelson-Morley experiment, Galilian transformations, basic postulates of special relativity, Lorentz transformations, length contraction and time dilation, mass energy relation.

Optics: Electromagnetic theory of light, Interference**:** Conditions for Interference of light, Young's double slit experiment, Newton's rings, diffraction**:** Single Slit diffraction pattern, Diffraction grating, Grating spectra, Polarization: Malus Law, Phenomena of double refraction.

Lasers: Properties of laser light**,** Main components of laser, absorption, spontaneous and stimulated emission, CW and pulsed lasers, Examples and applications: He-Ne laser, Ruby laser.

Quantum Theory: Need of Quantum theory, Photoelectric effect, Compton Effect, Heisenberg's uncertainty principle, de Broglie's hypothesis. Basic postulates of quantum mechanics, Wave function and its properties, Schrodinger's equation and its application to particle in 1-D box.

Nuclear physics: Structure of nucleus. Basic properties of nucleus (size, charge, and density), Binding energy, nuclear fission & fusion, Radioactivity, Gas detectors: GM counter.

Elementary Solid State Physics: Crystal lattice, Crystal structure, Unit cells, Miller Indices, Bravais lattice, Bragg's Law, Photographic crystal X-ray diffraction techniques, Laue's method. Free electron theory of metals, Classification of solids, formation of energy bands in metals, semiconductors and insulators, intrinsic and extrinsic semiconductors.

Text Books/Reference Books:

1. Griffiths D. J., Introduction to electrodynamics, *Pearson Education (India).*
2. Murray R. Speigel, Schaum's Outline on Vector Analysis, *McGraw Hill Education India.*
3. Upadhaya J. C., Classical Mechanics, *Himalaya Publishing House.*
4. Ghatak A., Optics, *McGraw Hill Education India.*
5. Besier A., Mahajan S., Choudhary S. R., Concepts of Modern Physics, *McGraw Hill Education India.*
6. Omar M. A., Elementary Solid State Physics, *Prentice Hall of India.*

CHM101C Chemistry 4-0-0

Chemical Thermodynamics: Introduction and Importance, First Law of Thermodynamics, Work done in Isothermal and Adiabatic Conditions, Heat capacities, Relation between C_p and C_v relations, Second Law of Thermodynamics, Concept of Entropy, Carnot engine, Gibbs free energy. Free Energy Changes as Criteria of Reversible and Irreversible process, Gibbs-Helmholtz's equation, Clausius–Clapeyron equation

Electro-Chemistry and Corrosion: Introduction, Conductivity of Electrolytes, Kohlrausch's Law of Independent Migration of Ions and its Application, Debye Huckel Theory of Strong Electrolytes. Electrochemical cells, Electrode-Potential, Standard Electrode Potential, Fuel Cells, Batteries, Introduction, Effects of Corrosion, Dry Corrosion and Wet Corrosion, mechanisms, Types of Corrosion (Pitting Corrosion, Crevice Corrosion, Galvanic Corrosion and Stress corrosion), Factors Effecting Corrosion (Nature of the Metal and Nature of the Environment), Corrosion Protection and Inhibition (Cathodic Protection, Anodic Protection, Protective Coatings)

Nano-Technology and Polymers: Nanoscale and Its Significance, Properties at Nanoscale: Optical, Electrical, and Magnetic. General Methods of Preparation of Nanomaterials viz Top Down (Ball Milling, Lithography) and Bottom up Methods (Sol-Gel, Solution Based Method), Advantages of Polymers over other Engineering Materials, Functionality, Degree of Polymerization, Concept of Molecular Weight, Polymerization (Addition, Condensation and Copolymerization), Polymerization Techniques (Bulk, Solution, Suspension and Emulsion polymerizations), Preparation, Properties and Engineering application of some Important Polymers, Polythene (LDPE and HDPE), Polyvinyl Chloride, Polystyrene, Teflon, Phenol Formaldehyde, urea-formaldehyde resin

Lubricants: Introduction, Function of Lubricants, Mechanism of Lubrication, Classification of Lubricants (Liquid, Semisolid, Solid), Properties of Lubricants (Flash Point and Fire Point, Viscosity, Aniline Point Acid value)

Instrumental Techniques: Introduction, Advantages and Disadvantages of Instrumental and Non-Instrumental Methods, Electromagnetic Radiation, Electromagnetic Spectrum, Light Absorption (Beers-Lambert Law) UV-Vis spectroscopy (Types of Transition, Chromophors, Auxo-chromes and Applications), Infrared Spectroscopy (Modes of vibration, IR bands corresponding to different functional groups and Applications), Nuclear Magnetic Resonance: Principle, shielding mechanism, chemical shift, number of Signals, Application of Nuclear Magnetic Resonance to Simple Organic Molecules.

Text Books/Reference Books:

1. Chemistry in Engineering and Technology Volumes I & II, J. Kuriacose, R. Rajaram, 2001, *TMH publishing company Limited, New Delhi.*
2. Engineering Chemistry, P.C. Jain, 16th Edition, *Dhanpat Rai & Sons, Nai Sarak; New Delhi.*
3. Chemistry of Engineering Materials, C.V. Agarwal, 9th Edition.
4. Chemistry in Engineering, L. A. Munro, 1964, *Prentice Hall, New York.*
5. Applied Chemistry for Engineers, R. M. E. Diamant, 3rd Revised Edition, *Pitman Publishing.*

6. Principles of Physical Chemistry – Puri, Sharma and Pathania, 2017, 4th Edition, *Vishal Publishing Co.*
7. Physical Chemistry by Peter Atkins, Julio de Paula, 8th Edition, 2006, *WH Freeman.*
8. Concise Inorganic Chemistry by J.D. Lee, 5th Edition, 2008, *Oxford University Press.*
9. Electrochemistry and Corrosion Science by N. Perez, 2nd Edition, 2016, *Springer.*
10. Polymer Science, V.R. Goowriker, N.V Viswanathan and Jayadev Sreedhar, 2nd Edition, 2015, N*ew Age International Publishers.*
11. Nanotechnology Fundamentals and Applications, Manasi Karkare, Rajni Bahuguna, 2013, *I K international.*
12. Nanotechnology Importance And Application, Fulekar, 2010, K *International Publishing House.*

MTH103C Mathematics-I 3-0-0

Brief Review of Differential Calculus: Limit, continuity and differentiability of functions of several variables, Chain rule, Jacobi theorem. Taylor's theorem of one and two variables, extrema of functions, two or more variables using method of Lagrange's multipliers.

Ordinary Differential Equations: Exact ordinary differential equations and Ordinary differential equations reducible to exact differential equations. Linear differential equations and equations reducible to linear form. Linear Differential equations of second and higher order with constant and variable coefficients. Applications of ordinary differential equations. Series solution of differential equations.

Vector Spaces: Linear dependence of vectors, Basis and Dimensions; Linear Transformations (maps), Range and Kernel of a linear map, Rank and Nullity, Inverse of a linear transformation, Rank-Nullity Theorem, Composition of Linear maps, Matrix associated with a linear map.

Algebraic Equations, Elements of the theory of polynomial equations. Fundamental theorem of Algebra, Relation between the roots and the coefficients of an equation, Solution of cubic & bi-quadratic equations.

Text Books:

1. Shanti Narayan, Differential calculus, *S. Chand & Sons*.
2. J. W. Brown, R. V. Churchill, Complex variables and Applications, *McGraw Hill Education India.*
3. Raisinghania M. D., Ordinary and Partial Differential equation, *S. Chand & Sons*.
4. Kreyszig I., Advanced Engineering Mathematics, *John Wiley & Sons.*

Reference Books:

1. James Stewart, Calculus, *Early Transcedentals*.
2. Bali N. P., A text Book on Engineering Mathematics, *Luxmi Publications.*
3. Jain R. K., Iyengar S. R. K., Advanced Engineering Mathematics, *Narosa Publications.*
4. Hoffmann & Kunze, Linear Algebra, *Prentice Hall of India.*
5. Piaggio H. T., Differential equations and its applications, *Prentice Hall of India.*
6. Sastry, Engineering mathematics Vol I-II, *Prentice Hall of India.*

BIO101F Environmental Science 3-0-0

Introduction to Environmental Science: Scope and importance, Public Environmental awareness and methods of its propagation, Consumerism and Green Consumerism. Environmental issues, Environmental Ethics-Anthropocentricism and Ecocentricism.

I**ntroduction to Ecosystem and Ecology**: Types of Ecosystems, Structure of an Eco system-biotic and abiotic components, Food chain and Food Web, Ecological Pyramids; Ecological Succession, Energy flow in an ecosystem, Major World Ecosystems and their characteristics.

Natural resources: Classification and their conservation; Biodiversity-Definition, values and threats to biodiversity; Classification of species as per IUCN; Hot Spots of Biodiversity. Conservation approaches – *In-Situ* and *Ex-Situ* conservation; Alternatives to conventional developmental approaches – Sustainable Development.

Introduction to global climate change: Greenhouse effect, global warming, acid rain, ozone layer depletion. Definition, Cause, effects and control measures of Air pollution, water pollution, soil pollution, noise pollution, thermal pollution and Solid waste pollution.

Field work (Field work equal to 5 lecture hours), Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc.

Text Books/Reference Books:

1. Ecology and Environment, P. D. Sharma, *Rastogi Publications*.
2. Environmental Science Towards a Sustainable Future, Nebel and Wright, *Prentice Hall of India.*
3. Environmental Studies, Erach Barucha, *Oxford Publications.*
4. Environmental Studies From Crises to Cure authored, R. Rajagopalan, *Oxford University Press.*
5. Environmental Management by Oberoi, *Excel Books.*
6. Principles of Environmental Science: Inquiry & Applications, William Cunningham & Mary Cunningham, *Tata McGraw Hill.*
7. Perspectives of environmental studies, A. P. Kaushik and C.P. Kaushik, *New Age International Publications.*

MEC101C Engineering Graphics and Design 1-0-4

Introduction: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance, Drawing instruments, lettering, Conic sections; Cycloid, Epicycloid, Hypocycloid and Involute; Scales.

Orthographic Projections: Principles of Orthographic Projections, Conventions, Projections of Points and lines inclined to both planes; Projections of planes inclined Planes, Auxiliary Planes;

Projections of Solids: Auxiliary Views; Draw simple annotation, dimensioning and scaling. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Sections of Solids: Prism, Cylinder, Pyramid, Cone, Auxiliary Views; Development of surfaces; sectional orthographic views, objects from industry and dwellings.

Isometric Projections: Principles of Isometric projection, Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa

Overview of Computer Graphics: Computer technologies, CAD software, the Menu System, Toolbars, Standard, Object Properties, Draw, Modify and Dimension, Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus, Different commands used in CAD, Isometric Views of lines, Planes, Simple and compound Solids.

Customisation & CAD Drawing: Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints.

Text Books:

1. Gill P. S., Engineering Drawing, *S. K. Kataria and sons.*
2. Bhatt N. D., Engineering Drawing, *Charotar Book Stall.*
3. James D. Bethune, Engineering Graphics with Auto CADD, *Pearson Education.*

Reference Books:

1. Shah M. B., Rana B. C., Engineering Drawing and Computer Graphics, *Pearson Education.*
2. Agrawal B., Agrawal C. M., Engineering Graphics, *TMH Publication.*

ENG101F Communication Skills 2-0-2

Vocabulary Building: The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Synonyms, antonyms, and standard abbreviations.

Basic Writing Skills, Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely.

Identifying Common Errors in Writing: Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés.

Nature and Style of sensible Writing: Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion

Writing Practices: Comprehension, Précis Writing, Essay Writing.

Oral Communication: (This unit involves interactive practice sessions in Language Lab): Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentations

Text Books/Reference Books:

1. Michael Swan, Practical English Usage, *OUP, 1995.*
2. Wood F. T., Remedial English Grammar, *Macmillan, 2007.*
3. William Zinsser, On Writing Well, *Harper Resource Book, 2001.*
4. Liz Hamp-Lyons and Ben Heasly, Study Writing, *Cambridge University Press, 2006*.
5. Sanjay Kumar and Pushp Lata, Communication Skills, *Oxford University Press, 2011.*
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad, *Oxford University Press.*

CIV150C Engineering Mechanics 3-0-0

Force Systems: Basic concepts, equilibrium of rigid bodies, system of forces, coplanar concurrent forces, components in space, resultants, moment of forces and its application, couples and resultant of force system, equilibrium of system of forces, free body diagrams, equations of equilibrium of coplanar systems and spatial systems, static indeterminacy.

Centroid and Second Moment of Area: Centroid of simple figures from first principle, centroid of composite sections; Area moment of Inertia**,** Moment of Inertia of plane sections from first principles, theorems of moment of inertia, moment of inertia of standard sections and composite sections.

Basic Structural Analysis: Equilibrium of deformable bodies, external and internal forces, stresses and strains in bars, basic introduction to beams, shear force and bending moment in simple beams, basic introduction to torsion, and analysis of trusses using method of joints.

Friction: Types of friction, limiting friction, dry friction, laws of friction, static and dynamic friction; motion of bodies, wedge friction, screw jack, friction clutches and brakes.

Centre of Gravity and Moment of Inertia: Centre of gravity and its implications; Mass moment of inertia, Moment of inertia of Cylinder, Cone, Sphere, etc.

Fundamentals of Dynamics: Kinematics and Kinetics of particles in rectilinear and curvilinear motion; Kinematics and Kinetics of Rigid bodies, types of motion, instantaneous centre of rotation in plane motion, D'Alembert's principle and its applications in plane motion and connected bodies, Work Energy principle, Impulse-Momentum principle, Impact.

Text Books:

1. Irving H. Shames, Engineering Mechanics, *Prentice Hall India, New Delhi.*
2. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, *Pearson Education.*

Reference Books:

1. F. P. Beer, E. R. Johnston, Vector Mechanics for Engineers, Vol I & Vol II, *McGraw Hill Education (India).*
2. Andy Ruina and Rudra Pratap, Introduction to Statics and Dynamics, *Oxford University Press.*
3. Shanes and Rao, Engineering Mechanics, *Pearson Education.*
4. Hibler and Gupta, Engineering Mechanics (Statics, Dynamics), *Pearson Education.*
5. Bansal R. K., A Text Book of Engineering Mechanics, *Laxmi Publications.*

MTH153C Mathematics-II 4-0-0

Integral Calculus: Definite Integrals and their properties, Differential under the sign of integration. Double and triple integrals, Change of variables, Beta and Gamma functions, Fourier series.

Non-linear differential equation of first order, Simultaneous differential equation, Simultaneous differential equation of the form $dx/P = dy/Q = dz/R$. Partial differential equations of first order, langrage linear equation, Standard form, Charpit`s Method to solve non- linear partial differential equation, Partial differential equations of second and higher order, Homogeneous Partial Differential equations with constant coefficients, Solutions by the method of separation of variables, heat flow equation, Wave equation.

Matrices: Eigen values and Eigen vectors of a matrix, Cayley-Hamilton Theorem, Symmetric, Skew-symmetric, Hermitian, skew- Hermitian, Orthogonal and unitary matrices and their properties, Diagonalization; Inner product spaces, Gram-Schmidt Orthogonalization.

Complex Variables: Differentiation, Cauchy-Riemann Equations, Analytic functions, Harmonic functions, elementary analytic functions(exponential, logarithmic and trigonometric) and their properties, Taylor's series and Laurent's series.

Text Books:

1. Kreyszig I., Advanced Engineering Mathematics, *John Wiley & Sons.*
2. Piaggio H. T., Differential equations and its applications, H *Prentice Hall of India.*
3. Raisinghania M. D., Ordinary and Partial Differential equation, *S. Chand & Sons.*

Reference Books:

1. James Stewart, Calculus, *Early Transcedentals.*
2. Hoffmann & Kunze, Linear Algebra, *Prentice Hall of India.*
3. Shanti Narayan, Integral Calculus by Shanty Narayan, *S. Chand & Sons.*
4. Greenberg, Advanced Engineering Mathematics, *Pearson education.*
5. Sastry, Engineering mathematics Vol I-II, *Prentice Hall of India.*

CSE150F Programming for Problem Solving 3-0-0

Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc. Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Branching, Loops, and Arrays: Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops. Arrays, Arrays (1-D, 2-D), Character arrays and Strings.

Algorithms, Order complexity and Functions: Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required), Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing
arrays to functions: idea of call by reference.

Recursion: Recursion as a different way of solving problems. Example programs, such as Finding Factorial,
Fibonacci series, Ackerman function etc. Quick sort or Merge sort, Structure, Structures, Defining structures and Array of Structures.

Pointers: Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling.

Text Books:

1. E. Balaguruswamy, Programming in ANSI C, *McGraw Hill Education India.*
2. Yashavant Kanetkar, Let Us C, *BPB Publications*

Reference Books:

1. Gottfried, Schaum's Outline of Programming with C, *McGraw Hill Education India.*
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, *Prentice Hall of India.*

MEC150C Workshop Practices 1-0-4

(i) Lectures and Videos

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
2. CNC machining, Additive manufacturing.
3. Fitting operations & power tools.
4. Electrical & Electronics.
5. Carpentry.
6. Plastic moulding, glass cutting.
7. Metal casting.
8. Welding (arc welding & gas welding), brazing.

(ii) Workshop Practice

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding, gas welding)
6. Casting
7. Smithy Shop

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology, Vol. I 2008 and Vol. II 2010, *Media promoters and publishers private limited, Mumbai.*
2. Kalpakjian S. And Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, *Pearson Education India Edition, 2002.*

Reference Books:

1. Gowri P. Hariharan and A. Suresh Babu, Manufacturing Technology – I, *Pearson Education, 2008.*
2. Roy A. Lindberg, Processes and Materials of Manufacture, 4th edition, *Prentice Hall India, 1998.*
3. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, *Tata McGraw Hill House, 2017.*

ELE150C Basic Electrical Engineering 3-0-0

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.

AC Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits, resonance in series and parallel RLC circuits. Three phase balanced circuits, voltage and current relations in star and delta connections.

Transformers: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Three-phase transformer connections.

Electrical Machines: Generation of rotating magnetic fields. Construction and working of a three-phase induction Motor. Significance of torque-slip characteristic. Starting of induction motor. Construction, working, torque-speed characteristic of separately excited dc motor. Construction and working of synchronous generators.

Electrical Installations: Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries.

Text Books:

1. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, *Tata McGraw Hill, 2010.*
2. D. C. Kulshreshtha, Basic Electrical Engineering, *McGraw Hill, 2009.*
3. V. D. Toro, Electrical Engineering Fundamentals, *Prentice Hall India, 1989.*

Reference Books:

1. E. Hughes, Electrical and Electronics Technology, *Pearson, 2010.*
2. Charles K. Alexender, Mathew N. O. Sadiku, Fundamentals of Electric circuits, *McGraw Hill,*
3. Jack E. Kemmerly William H. Hayt, Engineering Circuit Analysis, *McGraw Hill, 2012.*
4. L. S. Bobrow, Fundamentals of Electrical Engineering, *Oxford University Press, 2011.*

CSE151F **Programming Lab** **0-0-2**

List of Experiments

1. Familiarization with the programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

PHY150C **Physics Lab** **0-0-2**

List of Experiments

1. To determine the value of e/m of an Electron by Thompson Method
2. To determine the value of Acceleration due to gravity(g) by using Bar Pendulum
3. To determine the value of Acceleration due to gravity(g) by using Kater's Reversible Pendulum
4. To determine the Young's Modulus of rigidity of rectangular Steel Bar by Bending of Beam Method.
5. To determine the Wavelength of Sodium Light by Newton's Rings.
6. To determine the Wavelength of Laser Source by Fresnel Biprism
7. To determine the frequency of AC by Melde's Method
8. To determine The Resolving Power of Telescope.
9. To study the moment of Inertia of a Fly Wheel
10. To determine the refractive index of Crown Glass Prism.
11. To determine the wavelength of Sodium Light by Plane diffraction Grating.
12. To study the characteristics of Zener Diode.
13. To determine the Wavelength of Prominent lines of Mercury Light by Plane Diffraction Grating.
14. To study the characteristics of PN Junction Diode (Forward Bias)
15. To verify Biot-Savart's Law by showing that magnetic field produced is directly proportional to the current passed in a coil.
16. To study the characteristics of G.M. Tube.
17. To determine Planck's constant by LED Method.
18. To verify Stefan's Law by Electrical method.
19. Determination of Modulus of rigidity by Maxwell's Needle
20. Determination of velocity of Sound by Standing Wave Method.
21. To study the Hall Effect:
    (i) Determination of Hall Voltage and RH.
    (ii) Determination of mobility of charge carriers and carrier concentration

CHM150C **Chemistry Lab** **0-0-2**

List of Experiments

1. Basic Introduction on Solution Preparation, Concentration terms, Handling of Glass ware, Chemicals, Instruments: Precautions.
2. Determination of strength of NaOH solution by standardization of sodium hydroxide using Oxalic acid
3. To determine the acid value of a given mineral oil or vegetable oil.
4. To determine the moisture content of a given sample of coal.
5. To determine the Degree of dissociation of a weak acid by Conductometry.
6. Determination of the strength and pK_a value of the weak acid by titration with an alkali.
7. To determine the Aniline point of the given sample of a Lubricating oil.
8. Synthesis of the phenol formaldehyde resin.
9. To determine the temporary and permanent hardness of a sample of water by complexometric titration.
10. To determine the Alkalinity of the given sample of water.
11. Determination of the ion exchange capacity of cation exchange resin.

Demonstration Experiments

1. Determination of pH of different concentration of acid and bases by pH meter.
2. Spectrophotometer (concentration determination, wavelength maximum)

Text Books/Reference Books:

1. Laboratory Manual On Engineering Chemistry by S. K. Bhasin, S. Rani, 2009, *D R Publications.*
2. J. B. Yadav, Advanced Practical Physical Chemistry.

Annexure III
Structure of the undergraduate program in Mechanical Engineering

1. Humanities and Social Science including Management Courses

S. No.	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	T	P		
1.	ENG101F	Communication Skills	**2**	**0**	**2**	**I**	**3**
2.	MEC450C	Operations Research	**3**	**0**	**0**	**VIII**	**3**

2. Basic Science Courses

S. No.	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	T	P		
1.	PHY101C	Physics	**4**	**0**	**0**	**I**	**4**
2.	CHM101C	Chemistry	**4**	**0**	**0**	**I**	**4**
3.	MTH103C	Mathematics-I	**3**	**0**	**0**	**I**	**3**
4.	BIO101F	Environmental Science	**3**	**0**	**0**	**I**	**3**
5.	MTH153C	Mathematics –II	**4**	**0**	**0**	**II**	**4**
6.	PHY150C	Physics Lab	**0**	**0**	**2**	**II**	**1**
7.	CHM150C	Chemistry Lab	**0**	**0**	**2**	**II**	**1**
8.	MTH203C	Applied Mathematics for Engineers	**3**	**0**	**0**	**III**	**3**
9.	STA303C	Probability and Statistics	**3**	**0**	**0**	**V**	**3**
10.	MTH403C	Numerical Methods in Engineering	**3**	**0**	**0**	**VII**	**3**
						Total Credits	**29**

3. Engineering Science Courses

S. No.	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	T	P		
1.	MEC101C	Engineering Graphics and Design	**1**	**0**	**4**	**I**	**3**
2.	CIV150C	Engineering Mechanics	**3**	**0**	**0**	**II**	**3**
3.	CSE150F	Programming for Problem Solving	**3**	**0**	**0**	**II**	**3**
4.	MEC150C	Workshop Practices	**1**	**0**	**4**	**II**	**3**
5.	ELE150C	Basic Electrical Engineering	**3**	**0**	**0**	**II**	**3**
6.	CSE151F	Programming Lab	**0**	**0**	**2**	**II**	**1**
7.	ECE280C	Basic Electronics Engineering	**3**	**0**	**0**	**IV**	**3**

8.	ELE280C	Electrical and Electronics Lab	**0**	**0**	**2**	**IV**	**1**
9.	ECE330C	Microcontrollers	**3**	**0**	**0**	**V**	**3**
						Total Credits	**23**

4. Professional Core Courses

S. No.	**Course Code**	**Course Title**	**Hours Per Week**			**Semester**	**Credits**
			L	**T**	**P**		
1.	MEC201C	Machining Processes	**3**	**0**	**0**	**III**	**3**
2.	MEC202C	Mechanics of Solids	**4**	**0**	**0**	**III**	**4**
3.	MEC203C	Basic Thermodynamics	**3**	**0**	**0**	**III**	**3**
4.	MEC204C	Machine Drawing & Solid Modelling	**1**	**0**	**4**	**III**	**3**
5.	MEC205C	Fluid Mechanics	**4**	**0**	**0**	**III**	**4**
6.	MEC250C	Applied Thermodynamics	**3**	**0**	**0**	**IV**	**3**
7.	MEC251C	Mechanics of Materials	**3**	**0**	**0**	**IV**	**3**
8.	MEC252C	Theory of Machines and Mechanisms	**4**	**0**	**0**	**IV**	**4**
9.	MEC253C	Materials Science and Engineering	**3**	**0**	**0**	**IV**	**3**
10.	MEC301C	Heat and Mass Transfer	**4**	**0**	**0**	**V**	**4**
11.	MEC302C	Design of Machine Elements	**3**	**0**	**0**	**V**	**3**
12.	MEC303C	Manufacturing Processes	**3**	**0**	**0**	**V**	**3**
13.	MEC304C	Measurement & Instrumentation	**3**	**0**	**0**	**V**	**3**
14.	MEC350C	Advanced Manufacturing Processes	**4**	**0**	**0**	**VI**	**4**
15.	MEC351C	Machine Design	**3**	**0**	**0**	**VI**	**3**
16.	MEC352C	Mechanical Vibrations	**4**	**0**	**0**	**VI**	**4**
17.	MEC401C	Hydraulics & Hydraulic Machines	**3**	**0**	**0**	**VII**	**3**
18.	MEC402C	Industrial Engineering	**3**	**0**	**0**	**VII**	**3**
19.	MEC210C	Mechanics of Solids Lab	**0**	**0**	**2**	**III**	**1**
20.	MEC211C	Machining Processes Lab	**0**	**0**	**2**	**III**	**1**
21.	MEC260C	Thermo-Fluids Lab	**0**	**0**	**2**	**IV**	**1**
22.	MEC310C	Heat Transfer Lab	**0**	**0**	**2**	**V**	**1**
23.	MEC311C	Manufacturing Processes Lab	**0**	**0**	**2**	**V**	**1**
24.	MEC360C	Mechanisms & Vibrations Lab	**0**	**0**	**2**	**VI**	**1**
25.	MEC361C	CAD/CAM Lab	**0**	**0**	**2**	**VI**	**1**

26.	MEC410C	Industrial Engineering Lab	**0**	**0**	**2**	**VII**	**1**
27.	MEC411C	Fluid Machines Lab	**0**	**0**	**2**	**VII**	**1**
						Total Credits	**69**

5. Discipline Centric Electives

S. No.	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	T	P		
1.	MEC350E	Introduction to Tribology	**3**	**0**	**0**	**VI**	**3**
2.	MEC351E	Computer Aided Manufacturing	**3**	**0**	**0**	**VI**	**3**
3.	MEC352E	Mechatronics	**3**	**0**	**0**	**VI**	**3**
4.	MEC353E	Composite Materials	**3**	**0**	**0**	**VI**	**3**
5.	MEC354E	Refrigeration and Air Conditioning	**3**	**0**	**0**	**VI**	**3**
6.	MEC401E	Control Systems	**3**	**0**	**0**	**VII**	**3**
7.	MEC402E	Advanced Welding Technology	**3**	**0**	**0**	**VII**	**3**
8.	MEC403E	Energy Systems and Management	**3**	**0**	**0**	**VII**	**3**
9.	MEC404E	Industrial Automation	**3**	**0**	**0**	**VII**	**3**
10.	MEC405E	Metrology and Inspection	**3**	**0**	**0**	**VII**	**3**
11.	MEC450E	Gas Dynamics	**3**	**0**	**0**	**VIII**	**3**
12.	MEC451E	Automobile Engineering	**3**	**0**	**0**	**VIII**	**3**
13.	MEC452E	Internal Combustion Engines	**3**	**0**	**0**	**VIII**	**3**
14.	MEC453E	Computational Heat Transfer and Fluid Flow	**3**	**0**	**0**	**VIII**	**3**
15.	MEC454E	Surface Engineering	**3**	**0**	**0**	**VIII**	**3**

6. Generic Electives

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC350G	Computer Aided Design	**3**	**0**	**0**	**VI**	**3**
2.	MEC351G	Introduction to programming in MATLAB®	**1**	**0**	**3**	**VI**	**3**
3.	MEC352G	Power Plant Engineering	**3**	**0**	**0**	**VI**	**3**
4.	MEC401G	Finite Element Methods	**3**	**0**	**0**	**VII**	**3**
5.	MEC402G	Non-Conventional Sources of Energy	**3**	**0**	**0**	**VII**	**3**
6.	MEC403G	Principles of Management	**3**	**0**	**0**	**VII**	**3**

7.	MEC450G	Fracture Mechanics	**3**	**0**	**0**	**VIII**	**3**
8.	MEC451G	Introduction to Robotics	**3**	**0**	**0**	**VIII**	**3**

7. Open Electives

S. No.	**Course Code**	**Course Title**	**Hours Per Week**			**Semester**	**Credits**
			L	**T**	**P**		
1.	MEC001	Optimization Techniques	**3**	**0**	**0**	**-**	**3**
2.	MEC002	Quality Management	**3**	**0**	**0**	**-**	**3**
3.	MEC003	Concurrent Engineering	**3**	**0**	**0**	**-**	**3**
4.	MEC004	Maintenance Engineering	**3**	**0**	**0**	**-**	**3**
5.	MEC005	Fundamentals of Manufacturing Processes	**3**	**0**	**0**	**-**	**3**
6.	MEC006	Solar Energy	**3**	**0**	**0**	**-**	**3**
7.	MEC007	Basic Automobile Engineering	**3**	**0**	**0**	**-**	**3**
9.	MEC008	Basic Mechanical Engineering	**3**	**0**	**0**	**-**	**3**

Annexure IV

Vetted Course Outline for B. Tech. Mechanical Engineering, Batch 2018 Onwards

Semester-III

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC201C	Machining Processes	**3**	**0**	**0**	**3**	**3**
2.	MEC202C	Mechanics of Solids	**4**	**0**	**0**	**4**	**4**
3.	MEC203C	Basic Thermodynamics	**3**	**0**	**0**	**3**	**3**
4.	MEC204C	Machine Drawing & Solid Modelling	**1**	**0**	**4**	**5**	**3**
5.	MEC205C	Fluid Mechanics	**4**	**0**	**0**	**4**	**4**
6.	MTH203C	Applied Mathematics for Engineers	**3**	**0**	**0**	**3**	**3**
7.	MEC210C	Mechanics of Solids Lab	**0**	**0**	**2**	**2**	**1**
8.	MEC211C	Machining Processes Lab	**0**	**0**	**2**	**2**	**1**
Total Credits							**22**

Semester-IV

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC250C	Applied Thermodynamics	**3**	**0**	**0**	**3**	**3**
2.	MEC251C	Mechanics of Materials	**3**	**0**	**0**	**3**	**3**
3.	MEC252C	Theory of Machines and Mechanisms	**4**	**0**	**0**	**4**	**4**
4.	MEC253C	Materials Science and Engineering	**3**	**0**	**0**	**3**	**3**
5.	ECE280C	Basic Electronics Engineering	**3**	**0**	**0**	**3**	**3**
6.	MEC260C	Thermo-Fluids Lab	**0**	**0**	**2**	**2**	**1**
7.	ELE280C	Electrical and Electronics Lab	**0**	**0**	**2**	**2**	**1**
8.	-	Open Elective	**-**	**-**	**-**	**-**	**-**
Total Credits							**18**

Semester-V

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC301C	Heat and Mass Transfer	4	0	0	4	4
2.	MEC302C	Design of Machine Elements	3	0	0	3	3
3.	MEC303C	Manufacturing Processes	3	0	0	3	3
4.	MEC304C	Measurement & Instrumentation	3	0	0	3	3
5.	STA303C	Probability and Statistics	3	0	0	3	3
6.	ECE330C	Microcontrollers	3	0	0	3	3
7.	MEC310C	Heat Transfer Lab	0	0	2	2	1
8.	MEC311C	Manufacturing Processes Lab	0	0	2	2	1
9.	MEC312C	Project-I	0	0	2	30 (Total)	1
10.	-	Open Elective	-	-	-	-	-
Total Credits							22

Semester-VI

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC350C	Advanced Manufacturing Processes	4	0	0	4	4
2.	MEC351C	Machine Design	3	0	0	3	3
3.	MEC352C	Mechanical Vibrations	4	0	0	4	4
4.	MECXXXE	Elective-I (Discipline Centric)	3	0	0	3	3
5.	XXXXXXG	Elective-II (Generic)	-	-	-	-	X
6.	MEC360C	Mechanisms & Vibrations Lab	0	0	2	2	1
7.	MEC361C	CAD/CAM Lab	0	0	2	2	1
8.	MEC362C	Project-II	0	0	6	90 (Total)	3
9.	-	Open Elective	-	-	-	-	-
Total Credits							19+X

Semester-VII

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC401C	Hydraulics & Hydraulic Machines	**3**	**0**	**0**	**3**	**3**
2.	MEC402C	Industrial Engineering	**3**	**0**	**0**	**3**	**3**
3.	MTH403C	Numerical Methods in Engineering	**3**	**0**	**0**	**3**	**3**
4.	MECXXXE	Elective-III (Discipline Centric)	**3**	**0**	**0**	**3**	**3**
5.	XXXXXXG	Elective-IV (Generic)	**-**	**-**	**-**	**-**	**X**
6.	MEC410C	Industrial Engineering Lab	**0**	**0**	**2**	**2**	**1**
7.	MEC411C	Fluid Machines Lab	**0**	**0**	**2**	**2**	**1**
8.	MEC412C	Minor Project	**0**	**0**	**6**	**90 (Total)**	**3**
9.	-	Open Elective	**-**	**-**	**-**	-	**-**
Total Credits							**17+X**

Semester-VIII

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC450C	Operations Research	**3**	**0**	**0**	**3**	**3**
2.	MECXXXE	Elective-V (Discipline Centric)	**3**	**0**	**0**	**3**	**3**
3.	XXXXXXG	Elective-VI (Generic)	**-**	**-**	**-**	**-**	**X**
4.	MEC460C	Major Project	**0**	**0**	**18**	**270 (Total)**	**9**
5.	-	Open Elective	**-**	**-**	**-**	-	**-**
Total Credits							**15+X**

Electives (Discipline Centric)

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC350E	Introduction to Tribology	**3**	**0**	**0**	**3**	**3**
2.	MEC351E	Computer Aided Manufacturing	**3**	**0**	**0**	**3**	**3**
3.	MEC352E	Mechatronics	**3**	**0**	**0**	**3**	**3**
4.	MEC353E	Composite Materials	**3**	**0**	**0**	**3**	**3**
5.	MEC354E	Refrigeration and Air Conditioning	**3**	**0**	**0**	**3**	**3**
6.	MEC401E	Control Systems	**3**	**0**	**0**	**3**	**3**
7.	MEC402E	Advanced Welding Technology	**3**	**0**	**0**	**3**	**3**
8.	MEC403E	Energy Systems and Management	**3**	**0**	**0**	**3**	**3**
9.	MEC404E	Industrial Automation	**3**	**0**	**0**	**3**	**3**
10.	MEC405E	Metrology and Inspection	**3**	**0**	**0**	**3**	**3**
11.	MEC450E	Gas Dynamics	**3**	**0**	**0**	**3**	**3**
12.	MEC451E	Automobile Engineering	**3**	**0**	**0**	**3**	**3**
13.	MEC452E	Internal Combustion Engines	**3**	**0**	**0**	**3**	**3**
14.	MEC453E	Computational Heat Transfer and Fluid Flow	**3**	**0**	**0**	**3**	**3**
15.	MEC454E	Surface Engineering	**3**	**0**	**0**	**3**	**3**

Note:

1. *Department Level electives are offered to the students of the Department of Mechanical Engineering only.*
2. *The students of the Department of Mechanical Engineering have to choose Department Level Electives from the above list.*

Electives (Generic)

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC350G	Computer Aided Design	**3**	**0**	**0**	**3**	**3**
2.	MEC351G	Introduction to programming in MATLAB®	**1**	**0**	**2**	**3**	**2**
3.	MEC352G	Power Plant Engineering	**3**	**0**	**0**	**3**	**3**
4.	MEC401G	Finite Element Methods	**3**	**0**	**0**	**3**	**3**
5.	MEC402G	Non-Conventional Sources of Energy	**3**	**0**	**0**	**3**	**3**
6.	MEC403G	Principles of Management	**3**	**0**	**0**	**3**	**3**
7.	MEC450G	Fracture Mechanics	**3**	**0**	**0**	**3**	**3**
8.	MEC451G	Introduction to Robotics	**3**	**0**	**0**	**3**	**3**

Note:

1. *School Level electives are offered to the students of the School of Engineering and Technology including the students of the Department of Mechanical Engineering.*
2. *The students of the Department of Mechanical Engineering have to choose School Level Electives from the list of courses offered by all the Departments of School of Engineering and Technology.*

Open Electives

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC001	Optimization Techniques	**3**	**0**	**0**	**3**	**3**
2.	MEC002	Quality Management	**3**	**0**	**0**	**3**	**3**
3.	MEC003	Concurrent Engineering	**3**	**0**	**0**	**3**	**3**
4.	MEC004	Maintenance Engineering	**3**	**0**	**0**	**3**	**3**
5.	MEC005	Fundamentals of Manufacturing Processes	**3**	**0**	**0**	**3**	**3**
6.	MEC006	Solar Energy	**3**	**0**	**0**	**3**	**3**
7.	MEC007	Basic Automobile Engineering	**3**	**0**	**0**	**3**	**3**
9.	MEC008	Basic Mechanical Engineering	**3**	**0**	**0**	**3**	**3**

Note:

1. *Open electives are offered to the students of all Departments of the university other than the Department of Mechanical Engineering.*
2. *The students of the Department of Mechanical Engineering have to choose Open Electives offered by the departments other than the Department of Mechanical Engineering.*

Annexure V

Vetted Syllabus for B. Tech. Mechanical Engineering, Batch 2018 Onwards

MEC201C **Machining Processes** **3-0-0**

Introduction to Manufacturing: Manufacturing needs and Concepts, broad classification of engineering manufacturing processes. Introduction to Machining: Purpose, Principle and Definition. Concept of Generatrix and Directrix, tool- work motion and machine tool drives.

Basics of Metal Cutting: Principles of metal cutting, classification of Metal cutting/machining processes: Orthogonal and oblique cutting, Effect of tool geometry and other cutting parameters, Mechanisms of formation of chips, types of chips formed, chip Breaker.

Forces and Tool Life calculation in Metal Cutting: concept of specific cutting pressure, The forces acting on the cutting tool and their measurement, Merchant's circle diagram, force dynamometer, force and velocity relationship, Tool wear, Factors causing wear, tool life, variables affecting tool life, economical cutting speed, machinability of metals.

General Purpose Machine Tools: lathe, milling, shaping, slotting, planning, drilling, sawing, tapping, reaming, boring, broaching, grinding (cylindrical, surface, and centreless), thread rolling and gear cutting.

Grinding: Basic Principle, Purpose and application grinding. selection of wheels and their conditioning. Super and Micro Finishing Processes: Super finishing, Honing and Lapping. Screw thread and Gear Manufacturing Methods.

Text Books:

1. S. Kalpakjian and S. R. Schmid, Manufacturing engineering and technology, 7th edition of *Pearson publication.*

Reference Books:

1. P. N. Rao, Manufacturing Technology volume-I, 3rd edition of *TMH publication.*
2. R. K. Jain, Production Technology, 17th edition of *Khanna publishers.*

MEC202C Mechanics of Solids 4-0-0

Simple stresses and strains: Concept of stress and strain, general state of stress and strain at a point, strain and displacement field, mechanical properties of solids, the tensile test, one dimensional problems, statically determinate and indeterminate bars, temperature stresses and strains, generalized Hooke's law, transformation of stresses and strains, principal stresses and principal planes, plane stress and plane strain, Mohr's circle.

Stresses in Beams: Types of beams and loadings, shear force and bending moment diagrams, pure bending of symmetric beams, stresses in beams, flexure formula, beams of rectangular, circular, channel, I and T sections, combined direct and bending stresses, shear stress in beams, composite beams.

Deflection of Beams: Symmetric beams, double integration method, singularity functions, moment area method, slope and deflection for statically determinate beams.

Torsion: Torsional equation, solid and hollow circular shafts, solutions of statically determinate and indeterminate shafts subjected to twisting moments, strain energy due to torsion, power transmitted by shafts.

Columns and struts: Strength and stability of columns, end connections, critical loads, Euler's theory, Rankine's Theory, Johnson's parabola, eccentric loading of columns, beam columns.

Text Books:

1. Irving H. S., Introduction to Solid Mechanics, *Prentice Hall India, New Delhi*.
2. Popov E. P., Mechanics of Materials, *Prentice Hall India, New Delhi*.

Reference Books:

1. Ferdinand P. B., Johnston Jr. E. R., DeWolf J. T., Mazurek D. F., Mechanics of Materials, *McGraw Hill Education (India)*.
2. Crandall S. H., Dahl N. C., Lardner T. J., Sivakumar M. S., An Introduction to Mechanics of Solids, *McGraw Hill Education (India)*.
3. Timoshenko S., Strength of Materials Part 1, Elementary theory and problems, *CBS Publishers*.
4. Timoshenko S., Strength of Materials Part 2, Advanced theory and problems, *CBS Publishers*.

MEC203C Basic Thermodynamics 3-0-0

Introduction: Historical development, microscopic and macroscopic views of matter, thermodynamic systems, properties, processes, cycles, thermal equilibrium and Zeroth law of thermodynamics. The state postulate, pure substance, simple compressible substances and specific heat.

Concept of energy: Mechanical concept of energy, internal energy, conservation of energy, energy transfer as work, various modes, energy transfer as heat, First law for closed system, first law for cyclic processes,. Applications of first law for cycles. Enthalpy, Enthalpy of ideal gases, First law for open systems and applications.

Second law of Thermodynamics: Entropy and second law, Thermodynamic reservoirs, various statements and their equivalence, reversible cycle, Carnot cycle, efficiencies of reversible cycle, Carnot's theorem, coefficient of performance and reversed Carnot cycle. Thermodynamic temperature scale.

Application of second law: Clasius's theorem, entropy concept, principle of increase of entropy and its applications, Second law for closed system, Second law for open system. thermodynamic relations for ideal gases (computation of entropy and internal energy from measurable quantities).Exergy, principle of decrease of exergy, Exergy for open and closed systems and applications.

Heat and work transfer: Calculations involving heat transfer, work transfer and change in thermodynamic properties with various processes, Ideal gas mixture, internal energy, enthalpy, specific heat and entropy of an ideal gas mixture, air water vapour mixture. Complete and incomplete combustion analysis, heating value of fuels, A/F Ratios, analysis of products of combustion, Orsat apparatus.

Text Books:

1. Cengel Y. A., Thermodynamics: An Engineering Approach, *McGraw Hill Education (India).*

Reference Books:

1. Moran M. J., Shapiro, Fundamentals of Engineering Thermodynamics, *John Wiley & Sons.*
2. Sonntag R. E., Borgnakke C. and Van Wylen G. J., Fundamentals of Thermodynamics, *John Wiley & Sons.*
3. Wark K., Thermodynamics, *McGraw Hill Education (India).*
4. Nag P. K., Engineering Thermodynamics, *McGraw Hill Education (India).*

MEC204C Machine Drawing & Solid Modelling 1-0-4

Introduction to machine drawing: production drawing, assembly drawing. Review of drawing in 3rd angle projection. Orthographic projections of machine blocks, viz. Knuckle joint, Oldham's coupling, Footstep bearing and Tailstock.

Sectional views of machine blocks: (Half, Full) viz. riveted joints, bolted joints and Knuckle joint, Oldham's coupling, Footstep bearing and Tailstock.

Computer Aided Drafting (CAD): Theory of general engineering design, conceptual design, embodiment design involving layout and form designing to standard geometrical modelling. Basic sketching, lines and arcs, extrude and revolve features using CAD Software like SolidWorks and Autodesk Inventor.

Solid modelling with CAD: Various sub-components/parts of machine elements, viz. riveted joints, bolted joints and Knuckle joint, Oldham's coupling to be developed on SolidWorks, Autodesk Inventor.

Assembly modelling with CAD: Assembly of machine element components, viz. riveted joints, bolted joints and Knuckle joint, Oldham's coupling using SolidWorks and Autodesk Inventor.

Text Books:

1. Narayana K. L., Kannaiah P., Venkata Reddy K., Machine Drawing, *New Age International.*
2. Sham Tickoo, AutoCAD 2017 for Engineers & Designers, *Dreamtech Press*.
3. Junnarkar N. D., Machine Drawing, *Pearson Education India.*

Other Resources:

1. Engine model resources: http://grabcad.com
2. AUTODESK Inventor Professional 2016 (Free Student Licence).
3. SOLIDWORKS 2017-18 modelling Software.

MTH203C Applied Mathematics for Engineers 3-0-0

Laplace transform: shifting theorem, Laplace transforms of derivatives and integrals, Heaviside's unit function. Dirac Delta function and its Laplace transforms. Laplace transforms of periodic functions, Heaviside's expansion theorem.

Inverse Laplace transforms: initial and final value theorems. Convolution theorem and its applications, use of Laplace transforms in the solution of linear differential equations.

Complex analysis: Complex variables, analytic functions, Cauchy Riemann equations. Complex integration, Cauchy's fundamental theorem, Cauchy's integral formula, Cauchy's inequality and Liouville's theorem on integral function.

Expansions and Series in calculus: Taylor's & Laurent's expansions, Zeros & poles of analytic functions, Residues. Fourier series, Harmonic analysis.

Fourier transform: Fourier sine and cosine transform. Fourier integral formula and its applications to solution of boundary value problems.

Text Books/Reference Books:

1. Saff E. B., Snider A. D., Fundamentals of Complex Analysis for Mathematics, Science, and Engineering, *Prentice Hall India, New Delhi*.
2. Spiegel, Laplace Transforms, *Schaum Series*.
3. Churchill R. V., Complex variables and applications, *McGraw Hill Education (India)*.
4. Snedden N., The use of Integral Transforms, *McGraw Hill Education (India)*.

MEC205C Fluid Mechanics 4-0-0

Introduction to Fluid Mechanics: Fluid properties, fluid as continuum, incompressible and compressible fluids, stress at a point, Newton's law of viscosity, Newtonian fluids, concept of pressure, manometers, hydro-static forces on submerged plane and curved surfaces, rigid body motion of fluid.

Fluid kinematics: Eulerian & Lagrangian of fluid motion, velocity & acceleration, stream line, path line and streak line, 2D stream function in Cartesian & polar coordinates, translation, vorticity & angular velocity, circulation, flow classification.

Fluid dynamics: Dimensional analysis, system & control volume, basic & subsidiary laws, transport theorem, laws of conservation of mass, momentum & energy; integral & differential approaches, Euler's and Bernoulli's equations, Bernoulli's equation applications, Navier-Stokes equations, exact solutions.

Boundary layer theory: 2D laminar boundary layer flow, Prandtl B.L. equation, B.L. along a flat plate, Blassius solution, laminar to turbulent transition, concept of turbulent boundary layer theory.

Pipe flow: Laminar & turbulent flows: friction factor, Moody's diagram, energy losses through pipes, bends & pipe fittings, velocity distributions in pipes; power transmission through pipes constriction meter, pilot & pilot-static tubes.

Text Books:

1. White F. M., Fundamentals of Fluid Mechanics, *McGraw Hill Education (India).*

Reference Books:

1. Fox and McDonald, Introduction to Fluid Mechanics, *John Wiley & Sons.*
2. Munson B. R., Fundamental of Fluid Mechanics, *John Wiley & Sons.*

MEC250C Applied Thermodynamics 3-0-0

Steam Power Cycles: Carnot cycle for steam, Rankine and modified Rankine cycle, deviation of actual cycles from ideal cycles, cycle efficiency, second law analysis of vapour power cycle, binary vapor power cycles, Types of nozzles, isentropic flow through nozzles, effect of friction, nozzle efficiency, critical pressure ratio for maximum discharge, throat and exit areas, supersaturated flow.

Steam Turbines: Position of steam turbine in power industry, types and applications, impulse turbines, pressure and velocity compounding, velocity diagram, work output, blade, stage, internal and overall efficiency, reaction turbines, velocity diagram, degree of reaction, work out put, losses and efficiency, Reheat cycle, regenerative feed heating, Direct and indirect feed heating, efficiency and work out put calculations, governing of steam turbines.

Compressors: Single stage compressor, induction diagram and power requirement, effect of clearance volumetric efficiency, Multistage compressors, indicators diagram with and without clearance, effect of intercooling, power requirement,

Air standard Cycles: Carnot, Otto, diesel and dual cycles, work output and efficiency, mean effective pressure, deviation of actual cycles from ideal cycles.

Refrigeration Cycles: Refrigeration: Reversed Carnot, vapor compression and air refrigeration cycle analysis; vapor absorption cycle; refrigerants; domestic refrigerators.

Text Books:

1. Eastop T. D., Applied Thermodynamics for Engineering Technologist, *Pearson Education.*

Reference Books:

1. Cengel Y. A., Thermodynamics: An Engineering Approach, *McGraw Hill Education (India).*
2. Moran and Shapiro, Engineering Thermodynamics, *John Wiley & Sons.*
3. Arora C. P., Refrigeration and Air Conditioning, *McGraw Hill Education (India).*

MEC251C **Mechanics of Materials** **3-0-0**

Statically indeterminate beams: Slope and deflection, double integration method, singularity functions, moment area method, Clapeyron's three moment theorem, analysis of various statically indeterminate Beams.

Energy methods: Strain Energy for general state of stress, Strain Energy in axial, bending and torsional loads, energy of distortion, Castigliano's and Maxwell's Theorems, deflection of structures by energy methods.

Pressure vessels: Circumferential and longitudinal stresses in thin shells, cylindrical and spherical vessels, built-up cylindrical shells, wire wound cylinders, stresses in thick cylindrical and spherical shells, Lame's theory, compound cylinders, thick spherical shells.

Bending of curved bars: Stresses in curved bars, crane hooks, rings of circular and trapezoidal sections, deflection of curved bars and rings, deflection of rings by Castigliano's theorem, stresses in simple chain link, deflection of simple chain links.

Theories of elastic failure: Static strength, failure theories for ductile and brittle materials, maximum shear stress theory, distortion energy theory, maximum normal stress theory, Coulomb-Mohr theory, selection of failure criteria.

Text Books:

1. Irving H. S., Introduction to Solid Mechanics, *Prentice Hall India, New Delhi.*
2. Popov E. P., Mechanics of Materials, *Prentice Hall India, New Delhi.*

Reference Books:

1. Ferdinand P. B., Johnston Jr. E. R., DeWolf J. T., Mazurek D. F., Mechanics of Materials, *McGraw Hill Education (India).*
2. Crandall S. H., Dahl N. C., Lardner T. J., Sivakumar M. S., An Introduction to Mechanics of Solids, *McGraw Hill Education (India).*
3. Timoshenko S., Strength of Materials Part 1, Elementary theory and problems, *CBS Publishers.*
4. Timoshenko S., Strength of Materials Part 2, Advanced theory and problems, *CBS Publishers.*

MEC252C Theory of Machines and Mechanisms 4-0-0

Introduction to Mechanisms: Kinematics and dynamics, Lower pairs & higher pairs, Degree of freedom(DOF), Gruebler's and Kutzbach's criterion, Mechanisms and DOF, Inversions, Grashof's law and Quick return mechanism, Coupler curves, Velocity and acceleration analysis, Mechanical advantage, Transmission and deviation angle, Instantaneous centre.

Gears: Rolling contact and positive drive, classification of gears, Nomenclature, Law of gearing, Conjugate teeth, involute and cycloidal profile system of gear teeth, Length of path of contact, arc of contact, contact ratio, Interference and undercutting, interchangeable gears, Helical and spiral gears. Gear trains: Classification, Types, simple gear train, speed ratios, Compound, reverted, Epicyclic gear train, tabulation and algebraic method, Compound epicyclic gear trains.

Cams: Comparison with lower paired mechanisms, Classification of cams and followers, Terminology for cams, types of follower motions, pressure angle, considerations influencing choice of cam, construction of cam profiles, layout

Governors: Difference between flywheel and governor, Watt governor, Porter governor, analysis, effect of friction, Proell governor, Hartnell governor. Controlling force, sensitivity, stability, hunting, Isochronism, effort and power of a governor

Gyroscopes: Precessional motion and angular acceleration, Gyroscopic couple, reaction couple. Effects on an aero plane, naval ship, gyroscopic ship stabilization, Stability analysis of a two-wheel vehicle, Stability of a four-wheel drive on a curved path

Text Books:

1. Shigley J. E., Theory of Machines and Mechanisms, *McGraw Hill Education (India)*.

Reference Books:

1. Mabie H. H., Reinholtz C.F, Mechanism and Dynamics of Machinery", Fourth edition, *John Wiley & Sons.*
2. Rattan S. S., Theory of Machines, *McGraw Hill Education (India)*.
3. Ambekar A., Mechanisms and Machine Theory, *Prentice Hall India, New Delhi.*

MEC253C Materials Science and Engineering 3-0-0

Crystallography-crystals, space lattice, unit cell-BCC, FCC, HCP structures-effects of crystalline and amorphous structures on mechanical properties. Theoretical density; polymorphism and allotropy. Miller Indices: - Crystal plane and directions. Fundamentals and crystal structure determination by X-ray diffraction, SEM and TEM. Mechanism of crystallization: Homogeneous and heterogeneous Effects of grain size, grain shape Hall -Petch theory, simple problems.

Crystal defects-Classification of crystal imperfections: - types of dislocation- effect of point defects on mechanical properties, role of surface defects on crack initiation. Burgers vector –dislocation, correlation of dislocation density with strength and nano concept. Polishing and etching to determine the microstructure and grain size determination, diffusion in solids, Fick's laws, mechanisms, applications.

Phase diagrams: - Limitations of pure metals and need for alloying. Classifications of alloys and solid solutions, Hume- Ruthery rule, equilibrium diagram of common types of binary system. Liver rule and Gibb's phase rule. Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties change with phase transformation. Time temperature phase transformation diagram and heat treatments-applications. Surface hardening treatments and applications.

Strengthening mechanisms:- work hardening - precipitation strengthening and over ageing dispersion hardening , Cold working: Detailed discussion on strain hardening recovery; re-crystallization Alloy steels:- Effects of alloying elements on steel ,nickel steel ,high speed steel, stainless steel cast iron –classification and applications, principal nonferrous alloys

Failure of materials- Fracture:– Brittle and ductile fracture, Griffith theory of brittle fracture . - , Fatigue- Characteristics of fatigue failure and S-N curve, Creep: Creep curves

Composites: Need of development of composites, modern engineering materials, smart materials, shape memory alloys etc.

Text Books:

1. Raghavan V., Material Science and Engineering, *Prentice Hall India, New Delhi.*
2. Callister William. D., Material Science and Engineering, *John Wiley & Sons.*

Reference Books:

1. Askeland D. R., Fulay P. P., Essentials of Materials Science and Engineering, *Cengage Learning.*
2. George E. Dieter, Mechanical Metallurgy, *McGraw Hill Education (India).*

ECE280C Basic Electronics Engineering 3-0-0

Electronic Components: Active and Passive (Resistors, Capacitors and Inductors) components Introduction to Semiconductors: Extrinsic and intrinsic semiconductors, P and N type Semiconductors, Transport Mechanism of Charge Carriers, Charge Densities in a Semiconductor, Electric properties, Hall Effect, Generation, Recombination, Diffusion, Continuity Equation.

PN Junction Diodes and Rectifiers: PN junction Diode, Basic Principle, Operation and Volt-Ampere Characteristics of PN Junction Diode, Temperature Dependence of V/I Characteristics, Piecewise linear Diode Characteristics, Diode Resistance, Rectifiers: Half Wave Rectifier, Full Wave Rectifier (CT and bridge type), Diode Clipping and Clamping Circuits.

Transistors (BJT): Current Components of Transistor, Types, Transistor as a switch and as an Amplifier, Operation and Characteristics, CE, CB and CC Configurations, Input-Output Characteristics. Introduction to JFET, MOSFET and IGBT. Operation and Characteristics.

Number Systems and Codes: Binary, octal, and hexa- decimal number systems, binary arithmetic, binary code, excess-3 code, gray code, error detection and correction codes. Boolean algebra: Postulates and theorems, logic functions, minimization of Boolean functions using algebraic, Karnaugh map.

Combinational Logic Circuits: Introduction to combinational circuits, realization of basic combinational functions like Adder, Subtractor, Encoder/Decoder, Multiplexer, Demultiplexer. Introduction to Sequential Circuits, Realisation and Truth Table of RS, JK, D, T and Master Slave Flip-Flop.

Text Books:

1. C. Parikh, J. Millman, C. Halkias, Integrated Electronics, Analog & Digital Circuit System, *McGraw Hill Publishers*
2. Albert Malvino, David Dates, Electronic Principles, *McGraw Hill Publishers*
3. Kumar G.P, Principles of Electronics, *PHI Publishers*

Reference Books:

1. N.N. Bhargava and D.C. Kulshreshthaby N.N. Bhargava and D.C. Kulshreshtha, Basic Electronics and Linear Circuits, *McGraw Hill Publishers*.
2. S. Salivahnan , R Rengaraj, G R Venkatakrishnan, Basic Electrical, Electronics and Measurement Engineering, *McGraw Hill Publishers*

MEC301C Heat and Mass Transfer 4-0-0

Conduction: Basic laws of heat transfer, thermal conductance and resistance, combined heat transfer processes; Thermal conductivity of solids, liquids and gases. General heat conduction equation in Cartesian, cylindrical and spherical co-ordinate systems; One dimensional steady state heat conduction through composite walls. Variable thermal conductivity; Critical thickness of insulation. 1-D heat conduction with internal heat generation in plane wall, cylinder and sphere. Extended surfaces, Generalized equation for fins, Fin of uniform cross section: heat transfer rate, temperature distribution & fin efficiency for different conditions at fin tip. 1-D unsteady heat conduction; lumped heat capacity method, temperature-time response of thermocouples; Unsteady conduction with negligible surface resistance. Two dimensional (2D) steady heat conduction

Convection: Viscous flow, hydrodynamic and thermal boundary layers, Momentum and energy equations of the laminar boundary layer over a flat plate. Integral momentum analysis of the hydrodynamic boundary layer and thermal boundary layer for forced convection. Liquid metal heat transfer. Free convection heat transfer. Dimensional analysis applied to forced and free convection. Empirical equations for laminar and turbulent flows over surfaces of various geometries; simplified equations for air. Heat transfer during condensation, film condensation over a vertical surface. Phenomenon of boiling, Pool boiling over a heated nichrome wire.

Radiation: Introduction to thermal radiation, Plank's distribution law. Monochromatic and total emissive power, Emissivity, Stefan-Boltzmann law, Weins displacement law. Kirchoff's law; Proof of Kirchoff's law for monochromatic and total radiations. Solid angle, Intensity of radiation, Radiative heat exchange between two black surfaces, Shape factor, shape factor for simple geometries. Radiative heat exchange between non- black surfaces, Radiation shields. Radiation through gases and flames; Solar radiation

Heat Exchangers: Classification of heat exchangers and their temperature distributions; Overall heat transfer coefficient and fouling factors; Log mean temperature difference (LMTD). Heat exchanger effectiveness, NTU-method. Compact heat exchangers; Baffled shell and tube type heat exchangers. Heat exchangers design considerations. Heat Pipe

Mass Transfer: Introduction, diffusion and convective mass transfers, Ficks law of diffusion. Generalized equation of mass diffusion, steady state diffusion of gasses and liquids through solids, Isothermal evaporation of water into air. Convective mass transfers, mass transfer coefficients, analogy between momentum, heat and mass transfer.

Text Books:

1. Incropera F. P., Dewitt D. P., Fundamentals of Heat & Mass Transfer, *McGraw Hill Education (India).*

Reference Books:

1. Cengel Y. A., Heat transfer: A Practical Approach, *McGraw Hill Education (India).*
2. Holman J. P., Heat Transfer, *McGraw Hill Education (India).*

MEC302C Design of Machine Elements 3-0-0

Introduction to design: Various stages of design process, design tools and resources, standards and codes, safety, reliability and product liability, uncertainties in design, introduction to behavior of mechanical systems.

Failure prevention in mechanical components: Failures resulting from static loads, static strength, factor of safety, theories of failure for static loads, selection of failure theories, Introduction to fatigue in materials, various approaches to fatigue failure analysis and design, endurance limit and modifying factors, stress concentration and notch sensitivity, failure criteria for fluctuating loads.

Design of shafts: Shaft design for static and fatigue loads, shafts subjected to twisting and bending moments, deflection considerations, shaft materials, design of shaft components, keys and couplings.

Design of springs: Types of springs, stresses induced in helical springs, spring materials, design for static and fatigue loads, extension springs, torsion springs, spiral springs, leaf springs.

Design of permanent and temporary joints: Riveted joints, failures of riveted joints, design of riveted joints for boilers and pressure vessels, welded joints, welding symbols, butt and fillet welds, screwed joints, designation of screw threads, stresses induced in screw threads, bolt strength, design of cotter and knuckle joints.

Text Books:

1. Budynas R. G., Nisbett J. K., Shigley's Mechanical Engineering Design, *McGraw Hill Education (India).*

Reference Books:

1. Mott R. L., Machine Elements in Mechanical design, *Prentice-Hall Inc, New Jersey*.
2. Spotts M. F., Design of Machine Elements, *Prentice-Hall Inc, New Jersey*.
3. Bhandari V. B., Design of Machine Elements, *McGraw Hill Education (India).*
4. Sharma P. C., Aggarwal D. K., A Textbook of Machine Design, *S. K. Kataria and Sons India.*

MEC303C Manufacturing Processes 3-0-0

Introduction to Foundry and Casting: Metal Casting Processes: Patterns, Types of patterns, allowances and material used for patterns, moulding materials, moulding sands, Moulding sands; properties and sand testing: Grain fineness, moisture content, clay content and permeability test. Core materials and core making. Moulding practices: Green, dry and loam sand moulding, shell moulding; permanent moulding; carbon dioxide moulding. Gating and Rising design fundamentals, casting defects.

Metal Forming (Bulk Deformation): Metal working, Elastic and plastic deformation, Concept of strain hardening, Hot and cold working, Rolling, Principle and operations, Roll pass sequence, Forging, Forging operations, extrusion, Wire and tube drawing processes. Forging: Method of forging, Forging hammers and presses, Principle of forging tool design.

Sheet Metal Forming and Powder Metallurgy: Cold working processes: Shearing, Drawing Squeezing, Blanking, Piercing, deep drawing, Spinning, Bending, Coining and embossing, Metal working defects, cold heading, Riveting, Thread rolling bending and forming operation. Powder Metallurgy: Sintering, Impregnation and Infiltration.

Metal Joining Processes: Principle of welding, soldering, Brazing and adhesive bonding. Classification of welding and allied processes. Capabilities and applications; welding parameters, Gas welding and gas cutting, Arc welding, Power sources and consumables, Resistance welding: Spot, Projection and seam welding process, TIG, MIG, friction and explosive welding. Defects of welding and remedial actions.

Jigs and Fixtures: Definition, Differences between Jigs and Fixtures, Its usefulness in mass production, design principles, 3-2-1 location principle and its application to short and long cylinders, types of locators, concept of work piece control, geo metric control, dimensional control and mechanical control, Clamps, jig bushes, Jigs and fixtures for various machining operations.

Text Book:

1. Kalpakjian S., Schmid S. R., Manufacturing Engineering and Technology, *Pearson publication*.

Reference Books:

1. Rao P. N., Manufacturing Technology: Volume-II, *McGraw Hill Education (India)*.
2. Jain R. K., Production Technology, *Khanna publishers*.

MEC304C Measurement and Instrumentation 3-0-0

Introduction: Types of applications of Measurement Instrumentation: Monitoring of processes and operation, control of processes and operation, experimental engineering analyses, computer aided machines and processes.

Configuration, functional description, and performance of measuring instruments: Functional elements, Active and passive transducers, Analog and digital modes of operation, Input-output configuration of measuring instruments and instrument systems, Generalized performance characteristics of instruments, Static and Dynamic characteristics.

Motion and dimensional measurement: Fundamental standards, Relative and absolute motion devices, relative displacement, Resistive potentiometers, bridge circuit, LVDT, Variable inductance and variable capacitance pick-ups, Piezoelectric transducers, fiber optic displacement transducer, Resistance strain gage, Relative velocity-translational and rotational, Mechanical revolution counters and timers, stroboscopic method, Moving coil and moving magnet pickups, DC and AC tachometers, Eddy current drag-cup tachometer, Acceleration measurement.

Force, torque and shaft power measurement: Standards and calibration, Basic methods of force measurement, Elastic force transducers, Strain gauge transducers, Piezoelectric, Hydraulic and pneumatic load cells, Cantilever beam transducer, etc.; Torque measurements on rotating shafts; Shaft power measurements: Dynamometers – Absorption, driving and transmission type, reaction forces in shaft bearings, eddy current brake dynamometer.

Pressure, Flow and Temperature Measurement: Standards and Calibration, Methods of pressure measurement, Instruments for high, mid and low pressure measurement; Sound level meter, Microphones; Flow measurement: Orifice meters, Venturimeter, Pitot tube, Flow nozzle, rotameter, Positive displacement flow meter, turbine flow meter, ultrasonic flow meters; Temperature sensing techniques: liquid-in-glass and bimetallic thermometers, Pressure thermometers, electrical resistance thermometers, Thermistors, Thermocouples, etc.

Text Books:

1. Doeblin E.O., Measurement systems, *McGraw Hill Education (India).*
2. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, Mechanical Measurements, *Pearson publication.*

Reference Books:

1. Nakra B. C., Instrumentation, Measurements & Analysis, *McGraw Hill Education (India).*
2. Bolton W., Instrumentation and control systems, *Newnes Publications.*
3. Hollman J. P., Experimental Methods for Engineers, *McGraw Hill Education (India).*

STA303C Probability and Statistics 3-0-0

Statistics: Measures of central tendency and Measures of variations (Dispersions), Moments, Measures of Skewness and Kurtosis. Moment generating functions, problems.

Standard Distributions: Binomial, Poisson and Normal Distributions, Beta and Gamma Distribution, t Distribution, F-Distribution, Chi-square Distribution and their applications.

Method of Least Squares & Correlation: Methods of least squares, fitting of straight line and parabola of degree 'p'. Regression and Correlation. Multiple and Partial Correlation.

Probability: Random experiment, sample space, events, classical, statistical and axiomatic definitions of probability. Statements and proof of theorems on addition and multiplication of probabilities, problems.

Conditional Probability: Bayes theorem on conditional probability. Random variables, Derivation of formulae for mean, variance and moments of random variables for discrete and continuous cases. Laws of expectation problems.

Text Books/Reference Books:

1. Gupta S. C., Kapoor V. K., Fundamentals of Mathematical Statistics, *S. Chand & Sons.*
2. Brownlee, Statistical Theory and Methodology in Science & Engineering, *John Wiley & Sons.*
3. Walpole R. E., Introduction to Mathematical Statistics, *Macmillan publications*.
4. Meyer, Data Analysis for Scientists & Engineers, *John Wiley & Sons.*

ECE330C Microcontrollers 3-0-0

Microcontroller Architecture: Overview of 8051 Microcontroller family: Architecture, basic assembly language programming concepts, The program Counter and ROM Spaces in the 8051, Data types, 8051 Flag Bits ad PSW Register, 8051 Register Banks and Stack Instruction set, Loop and Jump Instructions, Call Instructions,

Timers: Time delay generations and calculations, I/O port programming Addressing Modes, accessing memory using various addressing modes, Arithmetic instructions and programs, Logical instructions, Single-bit instruction programming, Programming of 8051 Timers, Counter Programming.

Communication with 8051: Basics of Communication, Overview of RS-232, I^2C Bus, UART, USB, 8051 connections to RS-232, 8051 serial communication programming, 8051 interrupts, Programming of timer interrupts, Programming of External hardware interrupts, Programming of the serial communication interrupts, Interrupt priority in the 8051.

Interfacing with 8051: Interfacing an LCD to the 8051, 8051 interfacing to ADC, Sensors, Interfacing a Stepper Motor, 8051 interfacing to the keyboard, Interfacing a DAC to the 8051, 8255 Interfacing with 8031/51, 8051/31 interfacing to external memory.

Data Converters: Data converter fundamentals, Digital-to-Analog Converter (DAC) Specifications, Analog-to-Digital Converter (ADC) Specifications, DAC architectures, ADC architectures

Text Books:

1. Raj Kamal, Embedded Systems, *TMH, 2004*.
2. M.A. Mazidi and J. G. Mazidi, The 8051 Microcontroller and Embedded Systems, *PHI, 2004*

Reference Books:

1. David E. Simon, An Embedded Software Primer, *Pearson Education, 1999*.
2. K.J. Ayala, The 8051 Microcontroller, *Penram International, 1991*.
3. Dr. Rajiv Kapadia, 8051 Microcontroller & Embedded Systems, *Jaico Press*
4. Dr. Prasad, Embedded Real Time System, *Wiley Dreamtech, 2004*.
5. Muhammad Ali Mazidi , The 8051 Microcontroller and Embedded Systems: Using Assembly and C – VTU, *Pearson publishers*.

MEC350C Advanced Manufacturing Processes 4-0-0

Advanced Machining Processes/ Non- Conventional Machining Processes: EDM, ECM, ECG, CM, AJM, Wire cut EDM, USM, LBM process principle, process parameters and their applications. Process capabilities and their applications.

Advanced Casting Processes: Metal mould casting, continuous casting, squeeze casting, vaccum mould casting, evaporative pattern casting and ceramic shell casting.

Advanced Welding Processes: Atomic hydrogen, ultrasonic welding (USW), Plasma arc welding (PAW), laser beam welding (LBW), and Electron beam welding (EBW).

Advanced Metal Forming Processes: Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming and Contour roll forming.

Rapid Prototyping and Rapid Manufacturing: Introduction to Prototyping, Traditional Prototyping and Rapid Prototyping, Rapid Manufacturing Processes: Additive, Subtractive, Formative, Generic RP process.

Text Books/Reference Books:

1. Kalpakjian S., Schmid S. R., Manufacturing Engineering and Technology, *Pearson publication*.
2. Gibson D. W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, *Springer Publications*.

MEC351C Machine Design 3-0-0

Design of clutches and brakes: Types of clutches and brakes, analysis and design of different types of clutches and brakes.

Design of belt drives: Types of belt drives, velocity ratio of a belt drive, slip and creep in belts, design of flat belt drives, V-belt drives and rope drives, wire ropes, designation of wire ropes, stresses induces in wire ropes, design of chain drives.

Design of gear drives: Forms of gear teeth, Interference in gears, types of gears, Tooth systems, force analysis of different gears, design of spur and helical gears, Lewis bending equation, surface durability of gears, AGMA stress and strength equations, design of bevel gears and worm gears.

Design of bearings: Classification of bearings, journal bearings, types of lubrication, Petroff's equation, design considerations in journal bearings, thrust bearings, collar bearings, boundary lubricated bearings, rolling contact bearings and their types, designation of rolling contact bearings, bearing life and reliability, combined radial and thrust loading, variable loading, selection of ball, cylindrical and tapered roller bearings, lubrication in roller bearings.

Design of IC engine parts: Principal parts of an IC engine, design of engine cylinder, piston, piston rings, piston head, connecting rod, crankshaft, valves.

Text Books:

1. Budynas R. G., Nisbett J. K., Shigley's Mechanical Engineering Design, *McGraw Hill Education (India).*
2. Mott R. L., Machine Elements in Mechanical design, *Prentice-Hall Inc, New Jersey*.

Reference Books:

1. Spotts M. F., Design of Machine Elements, *Prentice-Hall Inc, New Jersey*.
2. Bhandari V. B., Design of Machine Elements, *McGraw Hill Education (India).*
3. Sharma P. C., Aggarwal D. K., A Textbook of Machine Design, *S. K. Kataria and Sons New Delhi India.*

MEC352C Mechanical Vibrations 4-0-0

Introduction: Fundamentals of vibration, classification of vibrations, discrete and continuous systems, elements of vibrating systems, harmonic motion, vibration analysis tools.

Single degree of freedom systems: Free vibration of undamped systems, first and second order systems, equations of motion, equilibrium and energy methods, Rayleigh's method, equivalent system method, undamped torsional systems, free vibrations of damped systems, different types of damping, viscous, coulomb and structural damping, logarithmic decrement, forced vibration of undamped and damped systems, harmonic excitations, resonance, harmonic motion of support, rotating unbalanced masses, self-excitation and stability analysis.

Two degree of freedom systems: Equations of motion, free vibrations of undamped systems, coordinate coupling, principal coordinates, Eigen value problems, natural modes of vibration, orthogonality of natural modes, undamped vibration absorbers.

Multi degree of freedom systems: Equations of motion, influence coefficients, stiffness, flexibility and inertia coefficients, undamped free vibrations, Eigen value problems, modal vectors, modal analysis, determination of natural frequencies and mode shapes, matrix methods, Rayleigh's method, Holzer Method, Jacobi's method, Dunkerley's Method.

Introduction to continuous systems: Vibration of strings, bars, shafts and beams, Rayleigh's method, orthogonality of modes, Rayleigh's quotient, wave equation, exact and approximate methods.

Introduction of Noise: Industrial Noise and Vibration Control: Basic sources of industrial noise and vibration, basic industrial noise and vibration control methods; The economic factor; Sound transmission from one room to another acoustic enclosures, acoustic barriers, sound absorbing materials; Vibration control procedures; Fault detection from noise and vibration signals.

Text Books:

1. Rao S. S., Mechanical Vibrations, *Prentice Hall India (Pearson), New Delhi*.
2. Meirovitch L., Fundamentals of Vibrations, *McGraw-Hill International Edition.*

Reference Books:

1. Kelly S. G., Mechanical Vibrations: Theory and practice, *Cengage Learning, USA*.
2. Dukkipati R. V., Srinivas J., Advanced Mechanical Vibrations, *Narosa Publishing India.*
3. Den Hartog J. P., Mechanical Vibrations, *Dover Publications*.
4. Thomson W. T., Theory of Vibrations with Applications, *CBS Publishers.*
5. Groover G. K., Mechanical Vibrations, *Nem Chand and Bros, New Delhi*.

MEC401C Hydraulics and Hydraulic Machines 3-0-0

Hydraulics: Power plant layout, hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes, jet striking centrally and at tip, velocity triangles at inlet and outlet, expressions for work done and efficiency-angular momentum principle, applications to radial flow turbines.

Hydraulic Turbines: Classification; energy transfer between rotor and fluid in turbomachines; impulse and reaction turbines-Pelton, Francis, Kaplan and tubular turbines – theory, losses, efficiencies, performance curves; draft tube, cavitation, governing, similarity laws, specific speed, model testing, governing, instrumentation for testing of hydraulic machines.

Pumps and compressors: Classification; centrifugal & axial flow pumps –theory, working principle, heads, losses, efficiencies, performance curves, surging, cavitation.

Positive Displacement Machines: Reciprocating Pump, gear pump, vane pump and screw pump, hydraulic systems: accumulator, intensifier, hydraulic lift, fluid coupling, torque converter, and fluidics.

Text Books/Reference Books:

1. Shepherd D. J., Principles of Turbo-Machines, *McGraw Hill Education (India).*
2. Jagdish Lal, Hydraulic Machines, *S Chand Publishers*
3. Cherkasky, Pump, fan and Blowers, *Mir Publications*
4. Stephonov ,Axial Flow Compressors, *Mir Publications*

MEC402C Industrial Engineering 3-0-0

Introduction: Definition and scope of industrial engineering, role of an industrial engineer in industry, functions of industrial engineering department and its organization, qualities of an industrial engineer, principles of industrial engineering, system and review of growth and development of industrial engineering and scientific management.

Plant Layout and Material Handling: Different types of layouts viz. product, process and combination layouts, introduction to layouts based on GT, JIT and cellular manufacturing systems, development of plant layout, types of material handling equipment, relationship of material handling with plant layouts.

Work Study: Use and Applications, techniques, human factors in the application of work study, method study objectives, basic procedure, various charting techniques, use of photographic techniques, SIMO charts, principles of motion economy, work measurement techniques, time study, work sampling, predetermined motion time standards (PMTS), analytical estimation.

Production Planning and Control: Functions, forecasting techniques, product design, process planning, machine loading and scheduling, dispatching, progress reporting, corrective action, inventory control - different costs, determining economic order quantity, quantity discounts, re-order level, re-order cycle systems, ABC, VED, FSN models.

Quality Control: Meaning of quality and quality control, quality of design, quality of conformance and quality of performance, functions of quality control, introduction to statistical quality control-control charts and sampling plans.

Text Books/Reference Books:

1. Khanna O. P., Industrial Engineering and Management, *Khanna Publishers*.
2. Dalela S., Mansuor Ali, Industrial Engineering and Management systems, *Standard Distributors and Publishers, New Delhi*.
3. Ralph M. B., Motions and Time Standards, *John Wiley & Sons*.
4. ILO - Introduction to Work Study, *International Labor Office, Geneva*.
5. Jain K. C., Agarwal L. N., Production Planning Control & Industrial Management, *Khanna Publishers*.

MTH403C Numerical Methods in Engineering 3-0-0

Finite Differences and Interpolation: Difference Table and its usage. The difference operators Δ, ∇ and the operator E. Interpolation with equal intervals, Newton's advancing difference formula. Newton's backward difference formula. Interpolation with unequal intervals. Newton's divided difference formula. Lagrange's interpolation formula.

Central Differences and Inverse interpolation: The central difference operator δ and the over raging operator μ. Relations between the operators. Gauss forward and backward interpolation formula, Sterlings, Bessel's, Laplace and Everetts formulae. Inverse interpolation by (i) Langrange's (ii) Methods of successive e approximation & (iii) Methods of elimination of third differences

Numerical solution of algebraic and Transcendental Equations and Numerical differentiation & Numerical Integration: Graphic Method, Regula-Fast method, Balzano's Process of bisection of intervals, Newton-Raphson Method and its geometrical significance. Numerical differentiation of a function. Differential coefficient of a function in terms of its differences. Numerical Integration, General Quadrature Formula, Trapezoidal rule, Simpson's one-third and three-eight rules, Weddles' rule, Euler- Maclaurin expansion formula.

Difference Equations and Numerical Solution of ordinary differential equations: Linear homogeneous and non-homogeneous difference equations of order n with constant coefficient, and their solution, methods of undetermined coefficient. Numerical solution of ordinary differential equations, Picard's method.Taylors series method, Euler's method, Runge-Kutta Method.

Numerical solution of simultaneous equations and Eigen value problem: Gauss elimination method, Gauss Jordon method, Gauss- Jacobi and Gauss- Seidel iteration methods, power methods for solving Eigen value problems.

Text Books/Reference Books:

1. Jain M. K., Iyengar S. R., Jain R. K., Numerical Methods for Scientists and Engineering, *Wiley Eastern Ltd.*
2. Scarborough S. C., Mathematical Numerical Analysis, *Oxford and IBH publishing Company*.
3. Sastry S. S., Introductory methods in Numerical Analysis, *Prentice Hall of India.*
4. Jain M. K., Numerical Solution of Differential equations, *New Age International Publishers.*
5. Stanton R. G., Numerical Methods for Science & Engineering, *Prentice Hall of India.*

MEC450C Operations Research 3-0-0

Operations Research, its Role in solving Industrial Problems, Mathematical Models, Decision Making Environments, Linear Programming, Graphical Method, Simplex Method, Duality, Transportation Problems, Assignment Problems, Goal Programming, Linear Goal Programming Problems.

Probabilistic Models, Uncertainties, Maxima and Minima, Decision Trees, Game Theory, Simple Two Person Zero-Sum Games, Simple Competitive Situations, Dynamic Programming, Deterministic and Probabilistic Dynamic Programming, Solution of Simple Problems.

Network Models, Shortest Route, Minimal Spanning Tree, Maximum Flow Models, CPM and PERT Networks, Critical Path Scheduling, Sequencing Models.

Inventory Models, Economic Order Quantity, Quantity Discount Models, Stochastic Inventory Models, Multi Product Models.

Queuing Theory, Queuing Systems, Parameters, Single Server And Multi Server Models, Poisson Input, Exponential Service, Constant Rate Service, Infinite Population, Simulation.

Text Books:

1. Taha H. A., Operations Research, *Prentice Hall India, New Delhi.*
2. Gupta P. K., Hira, D. S., Operations Research, *S. Chand & Co., New Delhi.*
3. Srinath L. S., PERT and CPM, Principles and Applications, *East-West Press, New Delhi.*

Reference Books:

1. Wagner H. M., Principles of Operations Research, *Prentice Hall India, New Delhi.*
2. Bazara M. J., Sherali J. H., Linear Programming and Network Flows, *John Wiley & Sons.*

MEC350E Introduction to Tribology 3-0-0

Introduction: Definition and History of Tribology, Industrial significance of Tribology, Origins and significance of Micro/ Nanotribology.

Solid Surface Characterization: The nature of surfaces, Physico-Chemical Characteristics of Surface Layers: deformed layer, chemically reacted layer, physisorbed layer, chemisorbed layer, Methods of characterization of surface layer. Analysis of surface roughness: Average roughness parameter, statistical analysis, fractal characterization and practical consideration in measurement of surface roughness. Measurement of surface roughness: mechanical stylus method, optical methods, scanning probe microscopy methods, fluid methods, electrical methods, electron microscopy method. Analysis of measured height distribution. Comparison of measurement methods.

Contact between Solid Surfaces: Introduction, Analysis of the contacts: single asperity contact of homogeneous and frictionless solids, single asperity contact of layered solids in frictional contacts, multiple asperity dry contacts. Measurement of the real area of contact: Measurement techniques, typical measurements.

Friction: Introduction, Solid-Solid contact: rules of sliding friction, basic mechanism of sliding friction, other mechanisms of sliding friction, friction transition during sliding, static friction, stick-slip, rolling friction. Liquid- Mediated contact. Friction of materials: metals and alloys, ceramics, polymers, solid lubricants.

Wear: Introduction, Types of wear mechanism: adhesive wear, abrasive wear, fatigue wear, impact wear, chemical wear, electrical arc induced wear, fretting and fretting corrosion. Types of particles present in wear debris: plate shaped particles, ribbon shaped particles, spherical particles, irregularly shaped particles. Wear of materials: Wear of metals and alloys, wear of ceramics, wear of polymers.

Text Books/Reference Books:

1. Bharat Bhushan, Introduction to Tribology, *John Wiley & Sons*.
2. Kalpajian S., Schmid S. R., Manufacturing Engineering and Technology, *Pearson Publications*.
3. Dwivedi D. K., Surface Engineering: Enhancing Life of Tribological Components, *Springer Publications*.

MEC351E Computer Aided Manufacturing 3-0-0

Introduction: Production system facilities, Support functions, automation principles and strategies, manufacturing operations, production concepts and mathematical models, Levels of automation, Numerical control technology, Computer numerical control, Direct and distributed numerical control.

Material Handling and Storage: Material handling system design, Principles of material handling, Industrial trucks, automated guided vehicle systems, rail guided vehicles, conveyor systems, cranes and hoists, analysis of material transport systems, Storage location strategies, performance of storage systems, conventional storage methods, automated storage systems, analysis of storage systems.

Group Technology and Cellular Manufacturing: Part families, part classification and coding, production flow analysis, cellular manufacturing, group technology, analysis of cellular manufacturing.

Flexible Manufacturing Systems: FMS components, applications and benefits, planning and implementation issues, analysis of flexible manufacturing systems.

Automatic Assembly Systems: Fundamental of assembly lines, assembly systems, line balancing algorithms, single and mixed model assembly lines, automated production lines, transfer lines without and with storage buffers, design of automated assembly systems, analysis of assembly systems.

Text Books:

1. Groover M. P., Automation Production Systems and Computer Integrated Manufacturing, *Prentice Hall India (Pearson), New Delhi.*

Reference Books:

1. Ranky P. G., Computer Integrated Manufacture, *Prentice Hall India (Pearson), New Delhi.*
2. Tien-Chien Chang, Richard A. Wysk, Hsu-Pin Wang, Computer-Aided Manufacturing, *Prentice Hall India (Pearson), New Delhi.*
3. Sawhney G. S., Fundamentals of Computer Aided Manufacturing, *I. K. International Publishing.*

MEC352E Mechatronics 3-0-0

Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modelling, Analysis and Simulation, Man-Machine Interface.

Sensors and transducers: Classification, Development in transducer technology, Optoelectronics-Shaft encoders, CD Sensors, Vision System, etc.

Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as Servo-motor/Stepper motor/Brushed and Brush-less DC motors, AC drives, Drive circuits, open and closed loop control;

Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems;

Smart materials: Shape Memory Alloys, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.

Micro-mechatronic systems: Micro-sensors, Micro-actuators; Micro-fabrication techniques. LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies. Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

Text Books:

1. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, *PWS Publishing Company*.
2. Bolton W., Mechatronics: A Multidisciplinary Approach, *Pearson Education India.*

Reference Books:

1. Rajput R. K., A Textbook of Mechatronics, *S. Chand & Company.*
2. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, *Prentice Hall India, New Delhi.*

MEC353E Composite Materials 3-0-0

Introduction to Composites: Fundamentals of Composites, Need For Composites, Classification Of Composites, Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Particle Reinforced Composites, Fibre Reinforced Composites.

Polymer Matrix Composites: Polymer Resins, Thermosetting Resins, Thermoplastic Resins, Reinforcement Fibres, Various Types Of Fibres, PMC Processes, Hand Lay Up Processes, Spray Up Processes, Compression Moulding, Reinforced Reaction Injection Moulding, Resin Transfer Moulding, Filament Winding, Injection Moulding, Fibre Reinforced Plastics, Glass Fibre Reinforced Plastics, Laminates.

Metal Matrix Composites: Characteristics Of metal matrix composites, Types Of Metal Matrix Composites, Reinforcements, Rule Of Mixtures, Processing Of metal matrix composites, Powder Metallurgy Process, Diffusion Bonding, Stir Casting, Squeeze Casting, Interface Properties.

Ceramic Matrix Composites: Ceramic Materials, Types Of Ceramic Matrix Composites, Oxide Ceramics, Non Oxide Ceramics, Reinforcements, Sintering, Hot Pressing, Cold and hot Isostatic Pressing, Processing Of Ceramic Matrix Composites.

Mechanics Of Composites: Lamina Constitutive Equations, Lamina Assumptions, Homogeneous Orthotropic Lamina, Isotropic Limit Case, Orthotropic Stiffness Matrix, Stress and Strain Displacement Relations, Basic Assumptions Of Laminated Anisotropic Plates, Laminate Constitutive Equations.

Text Books

1. Mathews F. L., Rawlings R. D., Composite Materials: Engineering and Science, *Chapman & Hall Publications*.

Reference Books:

1. Chawla K. K., Composite Materials, *Springer Publications*.
2. Clyne T. W., Withers P. J., Introduction to Metal Matrix Composites, *Cambridge University Press*.
3. Sharma S.C., Composite Materials, *Narosa Publications*.
4. Broutman L.J., Krock R.M., Modern Composite Materials, *Addison-Wesley Publications*.

MEC354E Refrigeration and Air Conditioning 3-0-0

Vapour Compression & Air Refrigeration Systems: Analysis of V.C. System, Multipressure System, Cascading V.C. Systems, Steam Jet Refrigeration, Cold preservation of food, cold storage.

Vapour Absorption Refrigeration System: Properties of binary mixture, processes executed by binary mixture, processes executed by binary mixtures, Acqua-Ammonia and LiBr Absorption systems; rectification. Non-conventional refrigeration systems: vortex tube, thermo electric, pulse-tube, thermo-acoustic refrigeration

Refrigerants: Primary& secondary refrigeration, properties and selection of refrigerants. Impact of CFC's on Ozone layer and global warming, Alternatives of CFS's. Components of conventional refrigeration systems: Evaporators, Condensers, Compressors, Expansion devices, Generator and Absorber, their types and selection.

Air-conditioning: Psychrometry of A.C. processes, Thermal comfort and Comfort chart, A.C. Systems, Cooling and heating loads. A.C. duct sizing, air distribution, fans, air cleaning, pipe sizing and layout. A.C. controls: elements of basic control systems, thermostats, humidistats dampers, sequencing of control operations.

Text Books:

1. Arora C. P., Refrigeration and Air Conditioning, *McGraw Hill Education (India).*

Reference Books:

1. Dossat R. J., Principles of Refrigeration, *John Wiley & Sons.*
2. Stoecker W. F., Jones J. F., Refrigeration and Air Conditioning, *McGraw Hill Education (India).*
3. Prasad M., Refrigeration and Air Conditioning, *New Age Publishers.*

MEC401E Control Systems 3-0-0

Introduction: Scope of Control System Engineer, Classification, Historical developments, Application in Engineering and non-Engineering fields; Mathematical modelling of physical systems, Transfer function, Block diagram algebra, Signal flow graphs.

Feedback Characteristics of Control systems: Feedback and non-feedback systems, Control over system dynamics, disturbances by use of feedback, Linearizing effect of feedback, Regenerative feedback.

Control Systems and Components: Nonlinearities, Linearization, Analogue Systems; Controller components: DC and AC Servomotors, Tacho-generators, Potentiometers and optical encoders, Stepper motors, etc.

Time Response Analysis and Design Specifications: Standard Test Signals, Time response of first order systems, Time response of a second order system; Steady State Errors and Error Constants; Effect of adding a zero to a system; Design specification of second order systems;

Stability and Algebraic Criteria: The concept of stability, Necessary conditions, Hurwitz stability criterion, Routh Stability Criterion, Relative stability analysis.

The Root Locus Technique: Angle and Magnitude Criterion, Properties of Root Loci, Construction of Root Locus Diagram, Closed Loop Transfer Function and Time Domain response, Determination of Damping ratio, Gain Margin and Phase Margin from Root Locus. MATLAB exercises on the above.

Frequency Response Analysis: Correlation between Time and frequency response, Frequency Domain Specifications; Polar Plots; Bode Diagrams; Minimum Phase, Non-minimum phase and all pass systems, Log Magnitude vs Phase plots; Nyquist stability criterion, Assessment of relative stability using Nyquist Criterion. MATLAB exercises on the above.

Text Books:

1. Norman S. Nise, Control Systems Engineering, *John Wiley & Sons.*
2. Nagrath I. J., Gopal M., Control System Engineering, *New Age International Publishers.*

Reference Books:

1. Kuo B. C., Automatic Control Systems, *John Wiley & Sons.*
2. Katsuhiko Ogata, Modern Control Engineering, *Prentice Hall India (Pearson), New Delhi.*

MEC402E Advanced Welding Technology 3-0-0

Introduction to welding and joining processes: Introduction to consolidation processes, Classification of welding processes, some common concerns, types of fusion welds and types of joints, Design considerations, Heat effects, Weld ability and join ability. Welding terms and definitions, welding positions, elements of and construction of welding symbols.

Welding Metallurgy (Physical Metallurgy and Solidification of Weld Metal): Fundamentals of physical metallurgy: Need, phase diagrams: Fe-C, Al-Cu, Cu-Zn system, phase transformations in Fe-C system, TTT diagram, CCT diagram, carbon equivalent, Schaffer diagram, relevance of above in welding. Solidification of weld metal: Principle of solidification of weld metal, modes of solidification, effect of welding parameters on weld structure, grain refinement principle of weld metal, method of weld metal refinement, inoculation, arc pulsation, external excitation.

Welding Metallurgy (HAZ, Weld Metal and Metallurgical issue of Weld Metal): Heat affected zone and weld metal: Transformations in HAZ of steel, factors affecting changes in microstructure and mechanical properties of HAZ, reactions in weld pool- gas metal reaction, slag metal reaction. Metallurgical issue in weld joint: Mechanisms, causes and remedy of cold cracking, solidification cracking, nonmetallic inclusions, lamellar tearing, hydrogen damage, banding, segregation.

Chemical, Metallurgical, and Mechanical testing of weldment: Comparison of destructive and non-destructive tests, chemical tests, forms of corrosion, testing for corrosion resistance, metallographic tests.

Weldment Inspection: Codes governing welding inspection: Structural welding code; ASME boiler and pressure vessel code, spot examination of welded joints, duties of the inspector, ASTM standards, API standards. Visual and liquid penetrant inspection, Magnetic particle and Radiographic inspection, Ultrasonic inspection and Eddy current inspection, acoustic emissions, proof tests and leak tests.

Text Book:

1. Larry J and Jeffus L, "Welding Principles and Applications", 5th edition, *Delmer Publications*

Reference Book:

1. Parmer R. S., 'Welding Engineering and Technology', *Khanna Publishers, 1997*

MEC403E Energy Systems and Management 3-0-0

Basic Fundamentals: Review of thermodynamics, fluid flow and heat transfer; concept of heat and work, different kinds of work, laws of thermodynamics; Fluid flow: laminar and turbulent flows, control mass and control volume, internal and external flows; Heat Transfer: modes of heat transfer, Fourier's law, forced and natural convection, radiation, Stefan-Boltzman's Law, Wein's displacement law, Kirchoff's law

Energy conversion systems: Furnaces, Turbine and its types, impulse and reaction turbines; Boilers: types, construction, and working principle, heat balance; internal combustion engines: SI, CI, gas turbines, operation and performance; Heat exchangers: types, construction. Parallel flow, counter flow, cross-flow, effectiveness of heat exchanger, NTU method.

Energy storage systems: Need for energy storage; Thermal energy storage technologies: sensible heat storage, latent heat storage, thermochemical storage: salt hydrates, metal hydrides, mechanical storage systems: pumped hydro, flywheel, electrochemical energy storage: batteries

Energy Management: Energy conservation: laws and regulations, present state of implementation and standardization and labeling in India, energy efficiency ratings for buildings and appliances, Energy monitoring, supply and demand estimation, energy pricing, CDM

Energy Audit and economics: Purpose, methodology, components of an energy audit, types of audits, energy auditing techniques, characteristic method employed in certain energy intensive industries, indoor air quality, economic analyses

Text Books:

1. Goswami D. Y., Kreith F., Energy conversion. *CRC Press.*
2. Cengel Y. A., Thermodynamics: An Engineering Approach, *McGraw Hill Education India.*

Reference Books:

1. Eastop T. D., Applied Thermodynamics for Engineering Technologist, *Pearson Education.*
2. Petrecca, Giovanni, Energy Conversion and Management, *Springer Publications.*
3. Younger W. J., Thumann A., Handbook of Energy Audits, *Fairmont Press.*

MEC404E Industrial Automation 3-0-0

Introduction to Automation: Socio Economic Consideration, Low Cost Automation, Fluid Power Control-Fluid Power Control Elements and Standard Graphical Symbols. Construction and Performance of Fluid Power Generators, Hydraulic and Pneumatic Cylinders- Construction, Design and Mounting; Hydraulic and Pneumatic Valves for Pressure, Flow and Direction Control, Servo Valves and Simple Servo Systems with Mechanical Feedback, Governing Differential Equation and Its Solution for Step Position Input, Basic Hydraulic and Pneumatic Circuits.

Pneumatic Logic Circuits: Design of Pneumatic Logic Circuits for a given Time Displacement Diagram or Sequence of Operations.

Fluidics: Boolean Algebra, Truth Tables, Conda Effect, Fluidic Elements – Their Construction Working and Performance Characteristics, Elementary Fluidic Circuits.

Transfer Devices and Feeders: Classification, Construction Details and Application of Transfer Devices and Feeders, Vibratory Bowl Feeder, Reciprocating Tube and Centrifugal Hopper Feeder.

Electrical and Electronic Controls: Introduction to Electrical and Electronic Controls such as Electromagnetic Controllers - Transducers and Sensors, Microprocessors, Programmable Logic Controllers (PLC); Integration of Mechanical Systems with Electrical, Electronic and Computer Systems.

Text Books:

1. Anthony Esposito, Fluid Power with Applications, *Prentice Hall of India, New Delhi.*
2. Majumdar S. R., Pneumatic Control, *Tata McGraw Hill, New Delhi.*
3. Deb S. R., Robotics and Flexible Automation, *Tata McGraw Hill, New Delhi.*

Reference Books:

1. Kuo B. C., Automatic Control Systems, *Prentice Hall, New Jersey*.

MEC405E Metrology and Inspection 3-0-0

Introduction to Metrology: Definition, types, need of inspection, terminologies, methods of measurement, selection of instruments, measurement errors, units, Measurement standards, calibration, statistical concepts in metrology, Steel rule, calipers, vernier caliper, vernier height gauge, Vernier depth gauge, micrometers, universal caliper, Limits fits and tolerances, Interchangeability, selective assembly, limits, fit and tolerances, limit gauging, design of limit gauges, computer aided tolerancing.

Types of Measurements: Measurement of straightness, flatness, squareness, parallelism, roundness and cylindricity, non-contact profiling systems. Taper measurement, angle measurement, radius Measurement.

Measurement of Surface Finish: Introduction, terminology, specifying roughness on drawings, surface roughness parameters, factors affecting surface roughness, ideal surface roughness, roughness measurement methods, precautions in measurement, surface microscopy, surface finish softwares.

Screw Thread Metrology and Gear Measurement: Introduction, screw thread terminology, screw thread measurement. types of gears, gear terminology, errors in gears, advanced measurement of spur gear.

Interferometry: Principle of interference, interference bands, interference patterns, flatness interferometer, Gauge length interferometer.

Advanced Metrology: Advanced measuring machines, CNC systems, Laser vision, In-process gauging, 3D metrology, metrology softwares, Nano technology instrumentation, stage position metrology, testing and certification services, optical system design, lens design, coating design, precision lens assembly techniques, complex opto mechanical assemblies, contact bonding and other joining technologies.

Text Books / Reference Books:

1. Hume K. J., Engineering Metrology, *Macdonald and Co. Publishers, London.*
2. Smith G. T., Industrial Metrology, *Spinger Publications*.
3. John W. Greve, Frank W. Wilson Hand book of industrial metrology, *Prentice Hall of India.*
4. Anthony D. M., Engineering Metrology, *Pergamon Press*.
5. Khare M. K., Dimensional Metrology, *Oxford Publishers.*

MEC450E Gas Dynamics 3-0-0

Introduction to Compressible flow and its applications: Review of Basic Equation in Differential and Integral Form (Mass, Momentum and Energy) for a viscous compressible flow and equations of states. Review of concepts of speed of sound in a stationary compressible medium and the Mach. No Basic differential equations for an inviscid compressible flow Dynamic similarity parameters in a compressible viscous flow.

Steady One Dimensional Flow Model: Basic Equations, Normal Shock Waves (Stationary), Oblique Shock Waves, Reflection & Interaction of Oblique Shock Waves, Expansion Waves Adiabatic Flow in a Constant area passage with friction, frictionless flow in a constant area passage with heat addition/removal.

Quasi-ID Steady Flows: Adiabatic Flow in a variable area passage without friction, Convergent-divergent nozzles and their operating characteristics. Convergent-divergent, Supersonic Diffusers, Generalized Quasi-ID Flow Governing Equations.

Unsteady wave motion: Moving normal shocks, reflected shock waves, Physical aspects of wave propagation, Basic elements of acoustic theory. Finite (Non-Linear) waves, Shock-tube relations, Finite compression waves.

Text Books/Reference Books:

1. Oosthuizen P.H., Carscallen W.E., Compressible Fluid Flow, *McGraw Hill Education (India).*
2. Zucrow & Hoffman, Gas Dynamics, *John Wiley and Sons.*
3. Shapiro, Dynamics & Theordynamics-Vol-1, *Ronald Press New York.*
4. Anderson Jr J.D., Modern Compressible Flow with Historical Perspective, *McGraw Hill Education (India).*

MEC451E Automobile Engineering 3-0-0

Introduction To Automobiles: Classification and Requirements of Automobile Body; Vehicle Frames, Unitised Body, Car Body Styles, Bus Body & Commercial Vehicle Body Types; Front Engine Rear Drive & Front Engine Front Drive Vehicles, Four Wheel Drive Vehicles, Safety Considerations.

Power Transmission: Requirements of Transmission System; General Arrangement of Power Transmission System; Gear Box; Types of Gear Boxes, Freewheel Unit, Overdrive Units, Advantage of Overdrive, Transaxle, Transfer Cases, Drive Lines, Differential and Drive Axles, Driving Thrust and Torque Reactions; Hotchkiss Drive, Torque Tube Drive and Radius Rods; Propeller Shaft, , Slip Joint; Constant Velocity Universal Joints; Front Wheel Drive; Principle, Function, Construction & Operation of Differential; Rear Axles, Types of Load Coming on Rear Axles, Full Floating, Three Quarter Floating and Semi Floating Rear Axles.

Suspension and Steering Systems: Need of Suspension Systems, Types of Suspensions; Factors Influencing Ride Comfort, Suspension Spring; Constructional Details and Characteristics of Leaf Springs, Steering Systems, Front Wheel Geometry & Wheel Alignment; Different Types of Steering Gear Boxes; Steering Linkages and Layout; Power Steering, Rack & Pinion Power Steering Gear, Electronics Steering.

Automotive clutches and Brakes: Tyres & Wheels, Classification of Brakes; Principle and Constructional Details of Drum Brakes, Disc Brakes; Brake Actuating Systems; Mechanical, Hydraulic, Pneumatic Brakes, Power & Power Assisted Brakes; Tyres of Wheels; Types of Tyre & Their Constructional Details, Wheel Balancing, Tyre Rotation; Types of Tyre Wear & Their Causes, Requirement of Clutches, Friction Clutch, cone Clutch, Plate Clutch, Spring Clutch, Multi Plate Clutch, Centrifugal Clutches, Electromagnetic Clutch, Over Running Clutch; Clutch Linkages.

Emission Control System & Automotive Electrical Systems: Sources of Atmospheric Pollution from the Automobiles, Emission Control Systems – Construction and Operation of Positive Crank Case Ventilation, Evaporative Emission Control, Heated Air Intake System, Exhaust Gas Recirculation Systems, Air Injection System and Catalytic Converters; Purpose Construction & Operation of Lead Acid Battery, Capacity Rating & Maintenance of Batteries; Purpose and Operation of Charging Systems, Purpose and Operations of the Starting System; Vehicle Lighting System.

Text Books:

1. Crouse W. H., Anglin D. L., Automotive Mechanics, *McGraw Hill Education (India).*

Reference Books:

1. Srinivasan S., Automotive Mechanics, *McGraw Hill Education (India).*
2. Anthony E. Schwaller, Motor Automotive Technology, *Delmar Cengage Learning.*
3. Sethi H. M., Automotive Technology, *McGraw Hill Education (India).*
4. Kirpal Singh, Automobile Engineering, *Standard Publishers Distributors.*

MEC452E Internal Combustion Engines 3-0-0

Introduction to IC Engines: Classification and major applications, engine performance parameters, design and performance data, comparison of Otto, Diesel and Dual cycles, two-stroke engines-operation, advantages and disadvantages, scavenging-methods and parameters, engine emissions

Fuel-Air cycles: Fuel-air cycles and their significance, effects of specific heat variation, dissociation and number of moles, effect of operating variables, idealized intake and exhaust processes, actual cycles, various losses encountered in SI and CI engines

Fuel injection: Mixture requirement in SI engines for steady state end transient operation, carburetion, fuel injection in CI and SI engines, supercharging and turbocharging, types of combustion chambers in SI and CI engines

Combustion: Combustion in SI engines, effect of engine variables on detonation, combustion in CI engines, effect of engine variables on delay period, comparison of knock in SI and CI engines, conventional fuels for SI and CI engines-requirements and their knock rating, alternative fuels and fuel additives

Gas turbines cycles: Thermodynamic analysis of actual gas turbine cycles, gas turbine cycles with intercooling, regeneration and reheating, jet propulsion- turbojet, turboprop, turbofan, ramjet and scramjet engines.

Text Books:

1. Ganesan V., Internal Combustion Engines, *McGraw Hill Education (India).*

Reference Books:

1. Heywood J. B., Internal Combustion Engine Fundamentals, *McGraw Hill Education (India).*
2. Hoag K., Dondlinger B., Vehicular Engine Design, *Springer Publications.*

MEC453E Computational Heat Transfer and Fluid Flow 3-0-0

Introduction to mathematical modelling: mathematical modelling of physical phenomena, governing differential equations- mass, energy, momentum, nature of coordinates, choice of coordinates

Discretization methods: concept of discretization, deriving the discretization equations: Taylor series formulation, variational formulation, method of weighted residuals, control volume formulation.

Modelling heat conduction: Steady 1-D conduction: equations, grid spacing, source term linearization, boundary conditions, solution of the linear algebraic equations; Unsteady 1-D conduction: general discretization equation, explicit and fully implicit schemes, Crank-Nicholson method, fully implicit discretization; 2-D situations, solution of algebraic equations; Over and under-relaxation.

Modelling convection and diffusion: Steady 1-D convection and diffusion: preliminary derivation, upwind scheme, exponential scheme, hybrid scheme, power law scheme, discretization for 2-D, one-way space coordinate, false diffusion

Modelling the flow field: Calculation of flow field, vorticity based methods, representation of pressure-gradient, representation of the continuity equation, staggered grids, momentum equation, pressure and velocity corrections, SIMPLE algorithm, SIMPLER algorithm

Text Books / Reference Books:

1. Patankar S.V., Numerical Heat Transfer and Fluid Flow, *Hemisphere Series on Computational Methods in Mechanics and Thermal Science.*
2. Muralidhar K., Sundararajan T., Computational Fluid Flow and Heat Transfer, *Narosa Publications.*

MEC454E Surface Engineering 3-0-0

Introduction to surface and their nature: Surface structure and properties, Surface Integrity, Surface Texture and Surface Roughness. Introduction to Tribology, Friction, Wear and Lubrication: Friction in Metals, Plastics and Ceramics, Friction Measurement. Wear: Wear of Plastic and ceramics. Lubricants: Metal Working Fluids, Solid Lubricants, Lubricant selection.

Introduction: purpose and need of surface engineering in industries, surface and subsurface region, properties of enhanced life and performance of mechanical components, classification of surface modification techniques, scope of surface engineering, role of surface properties affecting wearand friction behavior. Surface damages: types of wear and mechanism, adhesive wear, abrasive wear, erosive wear, corrosion wear and diffusive wear, techniques to evaluate damage of wear surface.

Materials for controlling wear: material properties (hardness, ductility, toughness, stacking fault energy, fatigue resistance, fracture toughness), selection of materials for surface engineering: iron base alloy, cobalt base alloy, nickel base alloy, copper base alloy, Structure and wear of material: ferrous metals, carbon steel, alloy steel, stainless steel, hadfield steel, gray cast iron, white iron, chromium iron, non-ferrous metals, cobalt base alloys and composite, nickel base alloys, functionally graded materials (FGM).

Surface Engineering by Changing the Surface Metallurgy: transformation hardening methods (flame hardening, induction hardening and Laser beam hardening), plastic deformation based approach (shot peening, burnishing and contour rolling and friction stir processing)

Surface Engineering by changing the composites: Carburizing (solid, liquid and gas), Nitriding, Surface modification using diffusion based processes, (PVD, CVD) vacuum deposition, ion implantation, sputtering, ion plating, boronizing.

Text Books / Reference Books:

1. Dwivedi D. K., Surface Engineering: Enhancing Life of Tribological Components, *Springer Publications*.
2. Rickerby D. S., Matthews A., Advanced Surface Coatings: A Handbook on Surface Engineering, *Springer Publications*.

MEC350G Computer Aided Design 3-0-0

Introduction: The design process, elements of CAD, 3D Modelling and Viewing, types of geometric models, coordinate systems, sketch planes, features, modelling aids and tools, geometric modifiers, layers, grids, clipping, arrays, offsetting, editing, principles of Software Design, characteristics of good software, algorithm Design, flow chart, coding, top-down programming, modular programming.

Curve Modelling: Curve entities, curve representation, analytical and synthetic curves, lines, circles, ellipses, parabolas, conics, cubic splines, Bezier curves, B-splines, NURBS, Knot vector, non-parametric and parametric equations, curve manipulations, blending, segmentation, trimming.

Surface Modelling: Surface entities, surface representation, surface analysis, tangent, normal and twist vectors, analytic surfaces and synthetic surfaces, plane surfaces, bilinear surface, ruled surfaces, tabulated cylinder, Bi-cubic surface, Bezier surface, B-spline surface, Coons surface, offset surface, Blending surface, surface manipulation techniques, displaying, segmentation, trimming.

Solid Modelling: Geometry and topology, Solid entities, Solid representation, set theory, set operations, half spaces, basic elements, and building operations, wireframe modeling, Boundary representation, Constructive Solid Geometry, CSG trees, sweeps, solid manipulations, segmentation, trimming, intersection, displaying.

Computer Graphics: Graphics display, transformations, translation, rotation, scaling, reflection and shearing, homogeneous coordinate systems, concatenated transformations, inverse transformations, mapping of geometric models, projections, orthographic projections, isometric projections, perspective projections, visualization, model cleanup, hidden line removal, hidden surface removal, shading, colours, computer animation, animation types, animation techniques.

Text Books:

1. Zeid I., Mastering CAD/CAM, *McGraw Hill Education (India)*.
2. Rao P. N., CAD/CAM; Theory and Practice, *McGraw Hill Education (India)*.

Reference Books:

1. Zeid I., CAD/CAM; Theory and Practice, *McGraw Hill Education (India)*.
2. Onwubiko C., Foundation of Computer Aided Design, *West Publishing Company*.
3. Sinha Hsu, Computer Aided Design: An Integrated Approach, *West Publishing Company*.
4. Rogers D. F., and Adams J. A., "Mathematical Elements for Computer Graphics", *McGraw Hill Education (India)*.

MEC351G Introduction to Programming in MATLAB® 1-0-3

MATLAB Basics: Introduction to MATLAB as a tool, Display Formats, Command window, Arithmetic Operations, Elementary Math Built-in Functions, Variables, Commands for Managing Variables, General Commands, Arrays, Matrices, Operations with Arrays and Matrices, Element-by-Element Operations.

Programming in MATLAB: Script files, Mat-files, Saving & Loading Data, Input and Output Commands, Global variables, Relational & Logical Operations, Branches & Control flow (if, switch), Loops (while, for).

Handling Graphics: Basic 2D plots, Specialized 2D Plots, 3D plots, style options, titles, and axes control, zoom, Saving and Printing Graphs.

User Defined Functions: Introduction, Function files, Variables Passing, Sharing Data using Global Memory, Nested Functions.

Engineering Applications: MATLAB exercises on Electrical Circuits, Control Systems and Engineering Mechanics.

Text Books:

1. Getting Started With MATLAB: A Quick Introduction, Rudra Pratap, *Oxford University Press, 2010.*
2. MATLAB programming for Engineers, Fifth Edition, Stephen J Chapman, *Cengage Learning.*

Reference Books:

1. MATLAB: An introduction with applications, Rao V Dukkipatti, *New Age International, 2008.*

MEC352G Power Plant Engineering 3-0-0

Fuels and Combustion: Thermodynamic cycle of steam flow: Rankine cycle, Actual Rankine cycle, Reheat cycle, Carnot cycle, heat rate, Classification of fuels, calorific value and its determination. Combustion equation, stoichiometric air fuel ratio, excess air requirement, actual air fuel ratio, flue gas analysis, pulverized coal firing system, fluidized bed combustion.

Thermal Power Plants: Types of boilers, Feed water and its treatment, Steam turbine and alternators, Site selection, Main parts and its working, Fuel handling, delivery of load, unloading, preparation, transfer, storage.

Hydroelectric Power Plants: General layout and arrangement of Hydroelectric power plants, Types of turbines, description and principles of impulse and reaction turbines, turbine characteristics, selection of turbines, governing of turbines.

Diesel Power Plants: Main components and its working, Diesel plant efficiency and heat balance, characteristics and selection of diesel power plant.

Nuclear Power Plants: Introduction, atomic physics and nuclear reactions, materials and site selection, nuclear reactors and working of each part. Layout and classification of nuclear power plants, nuclear waste disposal.

Text Books:

1. Nag P. K., Power Plant Engineering, *McGraw Hill Education (India)*.
2. Hedge R. K., Power Plant Engineering, *Pearson Education India*.

Reference Books:

1. M.M. El-Wakil, Power Plant Technology, *McGraw Hill, 2002*.
2. J.H. Rust, Nuclear Power Plant Engineering, *Haralson Pub Co., 1999*.
3. P.J. Potter, Power Plant Theory and Design, *Kreiger Pub. Co., 1988*.
4. E.B. Norris, and E. Therkelsen, Heat Power, *McGraw Hill, 1999*.

MEC401G Finite Element Methods 3-0-0

Introduction to Finite Element Method: Introduction to finite element method, weak formulations, variational formulations, approximation functions, weighted residual methods, virtual work principle, natural and essential boundary conditions.

One Dimensional Problems: Discretization of domain, elemental equations, connectivity of elements, interpolation functions and their properties, linear, quadratic and higher order shape functions, assembly of element equations, local and global stiffness matrix and its properties, boundary conditions, solution of equations, applications to solid mechanics, heat transfer and fluid mechanics problems, axisymmetric problems, transient problems.

Two Dimensional Problems: Single variable problems in 2-D, triangular elements, linear and higher order triangular elements, area coordinates, rectangular elements, higher order rectangular elements, natural coordinates, serendipity elements, numerical integration, master element, coordinate transformations, Jacobian matrix, evaluation of element matrices, boundary integrals, assembly of element equations, post computations, computer implementation.

Trusses: Basic truss element, plane truss, local and global coordinate systems, stress calculations, solution of practical problems.

Plane Elastic Problems: Governing equations for plane stress and plane strain, Weak formulations, finite element models for plane elastic problems, evaluation of boundary integrals.

Text Books:

1. Reddy J. N., An Introduction to Finite Element Methods, *McGraw Hill Education (India)*.

Reference Books:

1. Fish J. and Belytschko T., A First Course in Finite Elements, *John Wiley and Sons*.
2. Rao S. S., The Finite Element Method in Engineering, *Elsevier Publications*.
3. Liu G. R. and Quek S.S., The Finite Element Method; A Practical Course, *Butterworth Heinmann*.

MEC402G Non-Conventional Sources of Energy 3-0-0

Introduction: Role of energy in the development of society, Indian Energy Scenario, Conventional and Non-Conventional Sources, Energy demand and availability, Impact of energy use on the environment, Economic aspects.

Solar energy: Solar energy as an alternative source, Solar energy collectors, Focusing collectors, Estimation of direct and diffuse radiation, Analysis of flat plate collectors for air and water heaters.

Applications of solar energy: Solar heating and cooling of buildings, solar refrigeration, power generation from solar energy, solar ponds and solar stills, solar energy storage, principles of photovoltaic and solar cells.

Wind Energy resources: Global wind circulations; Indian sites for wind power; Aerodynamic design of wind turbine, Darreus rotor design, propeller type rotor design, blade loads, Governor and Yaw control; Economics of wind power.

Other non-conventional sources of energy: Biomass Conversions, MHD (Magneto-Hydro-Dynamic) Power generation system; Geothermal Energy; Energy from Ocean (Ocean Thermal Energy Technology and Energy from Tides).

Text Books/Reference Books:

1. Sukhatme S.P., Nayak J.K., Solar Energy and Applications, *McGraw Hill Education (India)*.
2. Khan B.H., Non-Conventional Energy Resources, *McGraw Hill Education (India)*.
3. Twidell J., and Weir T., Renewable Energy Resources, *Routledge*

MEC403G Principles of Management 3-0-0

Definition of management, science or art, manager vs entrepreneur; Types of managers managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management.

Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes.

Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Text Books/Reference Books:

1. Robins S.P. and Couiter M., Management*, Prentice Hall India.*
2. Stoner JAF, Freeman RE and Gilbert DR, Management, *Pearson Education.*
3. Tripathy PC & Reddy PN, Principles of Management*, Tata McGraw Hill.*

MEC450G Fracture Mechanics 3-0-0

Introduction to fracture mechanics: Historical development of fracture mechanics, basic concepts, stresses at crack tip, stress singularities, stress intensity factors, critical crack length, Griffith criterion, energy release rate, crack opening displacements, mechanisms of fracture and crack growth, brittle fracture, ductile fracture, fatigue crack growth, environment assisted cracking.

Linear elastic fracture mechanics: Crack deformation modes and basic concepts, crack tip stresses and deformation, Airy Stress Functions, Westergaard's stress function, Stress Intensity Factors, effect of finite size, crack tip plasticity, Irwin approach, Dugdale approach, shape of plastic zones, thickness effect.

Elastic-plastic fracture mechanics: The energy principles, the energy release rate, Crack resistance, R curves, compliance, the J integral, tearing modulus, Crack tip opening displacement, relationship between J integral and CTOD, use and limitations of J integral, two parameter fracture mechanics

Fatigue crack propagation: Introduction to fatigue failure, factors affecting fatigue crack growth, mechanism of fatigue crack growth, fatigue crack growth equations, crack closure, crack retardation models, effect of overloads, growth of short cracks.

Text Books:

1. Broek D., Elementary Engineering Fracture Mechanics, *Kluwer Academic Publishers, Netherlands*.
2. Anderson T. L., Fracture Mechanics; Fundamentals and Applications, *CRC Press, USA*.

Reference Books:

1. Gdoutos E. E., Fracture Mechanics; an Introduction, *Springer Publications, Netherlands*.
2. Schijve J., Fatigue of Structures and Materials, *Kluwer Academic Publishers, New York*.
3. Perez N., Fracture Mechanics, *Kluwer Academic Publishers, New York*.
4. Lee Y. Li, Pan J., Hathaway R., Barkey M., Fatigue Testing and Analysis, *Elsevier Publications, USA*.

MEC451G Introduction to Robotics 3-0-0

Introduction and classification: Definition, History of robots, Application of robots, Industrial applications, Classification of Robots, Actuators and Grippers.

Transformations: Kinematic constraints, Degrees of freedom and mobility, Pose of a rigid body, Coordinate Transformations, DH Parameters.

Kinematics: Forward position analyses, Inverse position analyses, Velocity analyses, Jacobian Matrix, Singularity, Forward and Inverse Velocity analyses, Acceleration analyses, Manipulator Design Requirements.

Dynamics and Control: Euler-Lagrange equations of motion for serial type manipulators; Inverse and Forward dynamic analyses, Linear control techniques, Transfer function and state space representation of dynamic system, A Robotic joint, PID control.

Text Books:

1. Saha S. K., Introduction to Robotics, *McGraw Hill Education (India)*.
2. Craig J. J., Introduction to Robotics, Mechanics and Control, *Pearson Education*.

Reference Books:

1. Siciliano B., Khatib O., Springer Handbook of Robotics, *Springer Publications*.

MEC001 Optimization Techniques 3-0-0

Classical Optimization: Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method, Kuhn-Tucker Conditions.

Single-variable Optimization: Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden-section Method, Quadratic Interpolation Method, Newton Method, Quasi-Newton Method, Secant Method.

Multi-variable Optimization: Evolutionary Optimization Method, Simplex Search Method, Pattern Search Method, Conjugate Direction Method, Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon-Fletcher-Powell Method.

Constrained Optimization: Interior Penalty Function Method, Exterior Penalty function Method.

Search Techniques: Genetic Algorithm, Simulated Annealing, Artificial Neural Networks.

Theory of Constraints: Introduction to TOC, Optimized Production Technology (OPT), Nine principles of OPT, Five Focusing Steps (The 5FS) of TOC, Capacity Constrained Resources and the Time Buffer, Modelling the Time Buffer, Modelling Return-On- Investment (ROI) in TOC, Comparison of TOC and Local Optimization Approaches.

Text Books:

1. Deb K., Optimization for Engineering Design: Algorithms and Examples, *Prentice Hall India, New Delhi*.
2. Rao S., Engineering optimization, Theory and Practice, *New Age International Publishers*.

Reference Books:

1. Ravindran A., Ragsdell K., Reklaitis G., Engineering Optimization: Methods and Applications, *John Wiley & Sons*.
2. Goldratt E. M., Cox J., The Goal: A Process of Ongoing Improvement, *North River Press*.

MEC002 Quality Management 3-0-0

Introduction: Different definitions, dimensions, and aspects of quality; Traditional and modern views of quality control; Different philosophies by quality Gurus, seven basic and new quality control tools.

Statistical Process Control: Theory and applications of control charts; Controls charts for variables; Charts for averages, ranges, and standard deviation; Control charts for attributes: p and c charts, fraction defective and number of defects per unit; Different adaptations of control charts, manufacturing process variability, manufacturing process capability and tolerances.

Acceptance Sampling: Concept of acceptance sampling; Sampling by attributes: Single and double sampling plans; Use of Dodge-Romming and military standard sampling tables, construction and use of OC curves; Sampling by variables: Continuous sampling plans.

Total Quality Management: Concept and philosophy, scope, applications, implementation, quality function deployment, six sigma, process capability, just-in-time philosophy, quality circles, quality system and introduction to ISO 9000 and ISO 14000; Taguchi method.

Reliability: Concept and definition, measurement and test of reliability, design for reliability, concepts of maintainability and availability.

Text Books:

1. Grant E., Leavenworth R., Statistical Quality Control, *McGraw Hill Education (India).*
2. Mitra A., Fundamentals of Quality Control and Improvement, *McGraw Hill Education (India).*
3. Juran J. M., Quality Control Handbook, *McGraw Hill Education (India).*

Reference Books:

1. Besterfield D. H., Besterfield M. C., Besterfield G., Besterfield S. M., Total Quality Management, *Prentice Hall India, New Delhi.*
2. Montgomery D. C., Introduction to Statistical Quality Control, *John Wiley & Sons.*

MEC003 Concurrent Engineering 3-0-0

Introduction: Concurrent engineering concepts, sequential versus concurrent engineering, framework of concurrent engineering, benefits of concurrent engineering, implementation of concurrent engineering, role of information technology, applications.

Design for Manufacturing and Assembly: Mathematical modelling between design and manufacturing, design for manufacturing and assembly approach, design for quality, design for cost, failure modes effects analysis, fault tree analysis, concurrent product design, material balance equation, cost equation, average manufacturing lead time, design of experiments, Taguchi's methods, quality function deployment.

Integration of Design and Manufacturing: Design evaluation for manufacturing cost, design process optimization for concurrent engineering, role of CAD/CAM and automation, tools and techniques for product development and interactive modeling and visualization, design for manufacturing, design for reliability, maintainability and reparability. .

Implementation and Case Studies: Difficulties associated with performing concurrent engineering, life cycle costing, case studies.

Text Books:

1. Biren Prasad, Concurrent Engineering Fundamentals, Vol. I & II, *Prentice Hall India, New Delhi.*
2. Backhouse C. J., Brookes, Concurrent Engineering, *Gower Publishing House*.
3. Moustapha I., Concurrent Engineering in Product Design and Development, *New Age International, New Delhi.*

Reference Books:

1. Andrew Kusiak, Concurrent Engineering, Automation, Tools and Techniques, *John Wiley & Sons.*

MEC004 Maintenance Engineering 3-0-0

Introduction: Maintenance engineering and its importance in inventory control, productivity, safety, pollution control, safety regulations, pollution problems, human reliability, total quality management, total productivity maintenance, environmental issues in maintenance.

Maintenance Strategies: Maintenance strategies, planned and unplanned maintenance, breakdown, preventive and predictive maintenance, computer aided maintenance, maintenance scheduling, spare part management, inventory control.

Tribology In Maintenance: Friction, wear and lubrication, friction and wear mechanisms, prevention of wear, lubrication types, lubricants, additives, testing of lubricants, degradation of lubricants.

Machine Health Monitoring: Condition based maintenance, signature analysis, oil analysis, vibration, noise and thermal signatures, online and off line techniques, instrumentation & equipment used in machine health monitoring, instrumentation in maintenance, signal processing, data acquisition and analysis, application of intelligent systems, data base design.

Reliability, Availability & Maintainability (RAM): RAM failure mechanism, failure data analysis, failure distribution, reliability of repairable and non-repairable systems, improvement in reliability, reliability testing, utilization factor.

Text books:

1. Gopalakrishnan P., Banerji A. K., Maintenance & Spare parts Management, *Prentice Hall India, New Delhi.*
2. Mishra R. C., Pathak K., Maintenance Engineering and Management, *Prentice Hall India, New Delhi.*
3. Higgins L. R., Morrow L. C., Maintenance Engineering Hand Book, *McGraw Hill Education (India).*

Reference Books:

1. Collacott, R. A., Mechanical Fault Diagnosis and Condition Monitoring, *Chapman and Hall.*
2. Davies N., Handbook of Condition Monitoring: Techniques and Methodology, *Springer Publications.*

MEC005 Fundamental of Manufacturing Processes 3-0-0

Introduction of Manufacturing Processes: An introduction to the scope and significance of manufacturing worldwide, need of manufacturing processes in making of computers, electronics and electrical devices etc.

Metal Casting Processes: Patterns, Types of patterns, molding materials, molding sands, properties and sand testing: Grain fineness, moisture content, clay content, Core materials and core making, Chaplets. Casting defects.

Welding Processes: Principle of welding, Classification of welding and allied processes. Capabilities and applications; welding parameters, , Gas welding and gas cutting, Arc welding, Power sources and consumables, TIG, MIG, friction welding. Defects of welding and remedial actions.

Machining: Basics of Metal Cutting: Principles of metal cutting, classification of Metal cutting/machining processes: Orthogonal and oblique cutting, Effect of tool geometry and other cutting parameters, Mechanisms of formation of chips, types of chips formed, chip Breaker.

Additive Manufacturing: Introduction to Additive Manufacturing: Rapid Prototyping Technology (SLS), 3D Printing Technology (FDM, etc.)

Text Books:

1. Manufacturing engineering and technology, by S. Kalpakjian and S. R. Schmid, 7th edition of *Pearson publication.*

Reference Books:

1. Manufacturing technology volume-II, by P. N. Rao, 3rd edition of *TMH publication.*
2. Manufacturing technology volume-I, by P. N. Rao, 3rd edition of *TMH publication.*

MEC006 Solar Energy 3-0-0

Introduction: Sun as the source of energy, Solar constant, Spectral distribution of extraterrestrial radiation, Variation of extraterrestrial radiation, Solar radiation geometry, Empirical relations for predicting the availability of solar radiation, radiation on inclined surfaces.

Measurement of Solar radiations: Measurement of diffused, global and direct solar radiations, Pyranometers and Pyrheliometers, working principle and types, concept of tracking

Flat Plate collectors: Introduction, Liquid flat plate collectors, materials for flat plate collectors, efficiency of flat plate collector, overall heat loss coefficient, collector efficiency, collector heat removal factor, temperature distributions in flat-plate collectors, overall heat loss coefficient, effect of various factors on performance, Solar air-heaters: introduction, performance analysis of a conventional air heater, other types of air heaters

Concentrating solar collectors: Introduction, concentration Ratio, Flat plate collectors with plane reflectors, Cylindrical Parabolic collectors, Compound parabolic collectors, paraboloid dish collector, central receiver collector, Fresnel collectors, thermal and optical performance of concentrating collectors

Solar PV: Photovoltaic conversion, single crystal Silicon solar cell: working and performance analysis, polycrystalline solar cells, applications. Other methods of solar energy utilization

Text Book:

1. Solar Energy: Principles of Thermal Collection and Storage, Sukhatme, S.P. and Nayak, J.K. 3rd Edition, *Tata-McGraw Hill*

Reference Book:

1. Solar Energy: Fundamentals and Applications, Garg, H.P. and Prakash, J. 1st Revised Edition, *Tata-McGraw Hill.*
2. Solar Engineering of Thermal Processes, John A. Duffie and William A. Beckman, 4th Edition, *John Wiley and Sons.*

MEC007 Basic Automobile Engineering 3-0-0

Introduction: Introduction to engines and their classifications, cooling system and lubrication system and their classification, engine performance parameters

Fuel injection: Carburetion, Introduction to fuel injection system in SIE and CIE, pump, fuel injector, valve timing, supercharging, turbocharging

Combustion in engines: Types of ignition system, Battery ignition and Magneto ignition systems their basic requirements and their standard wiring diagram. Types of spark plug, Ignition timing, Spark advance and retard

Transmission and suspension systems: Transmission train, conventional and non-conventional drives, Clutches, Gear boxes, Synchromesh device, Propeller shaft, Differential axle. Braking systems and their types. Suspension system and its types

Emission Control: Emissions and their types, emission control: BSIV. Exhaust gas treatment

Text Books:

1. Crouse W. H., Anglin D. L., Automotive Mechanics, *McGraw Hill Education (India)*.
2. Sethi H. M., Automotive Technology, *McGraw Hill Education (India)*.

Reference Books:

1. Srinivasan S., Automotive Mechanics, *McGraw Hill Education (India)*.
2. Anthony E. Schwaller, Motor Automotive Technology, *Delmar Cengage Learning*.
3. Kirpal Singh, Automobile Engineering, *Standard Publishers Distributors*.

MEC008 Basic Mechanical Engineering 3-0-0

Introduction to Mechanical Engineering: Recent advancements in mechanical engineering, Role of CAD, simulation and 3D printing in mechanical engineering, Scope of mechanical engineering.

Basic Thermodynamics: System and Surroundings, Laws of Thermodynamics, isochoric, isobaric, isothermal, adiabatic and polytrophic processes, Concept of Entropy, Carnot's Cycle, steam generators, introduction to Steam turbines, compressors and nozzles, ideal gas equation, gas turbines and their applications, introduction to refrigeration and air-conditioning, SI and CI engines.

Fluid Mechanics: General properties of fluids, Pressure measurement, Bernoulli Equation, introduction to impulse and reaction turbines, Governing of Steam Turbines, pumps, Fields of Application.

Power Transmission: Concept of machines and mechanisms, basic machine elements, gears, cams, flywheel, governors, clutches and brakes.

Strength of Materials: Basic concepts of stress and strain, axial stresses, types of beams, shear force and bending moments, introduction to torsion and buckling.

Basic Manufacturing: Introduction to manufacturing, basic manufacturing processes, metal cutting processes, introduction to casting, forming, welding and other fabrication processes, basic machine tools, lathes, milling machines, grinding machines etc.

Text Books / Reference Books:

1. Basant Agrawal, Basic Mechanical Engineering, *John Wiley & Sons.*
2. Pravin Kumar, Basic Mechanical Engineering, *Pearson Education India.*

MEC210C Mechanics of Solids Lab 0-0-2

List of Experiments:

1. To perform tensile tests on different specimens and draw stress-strain curves for these materials.
2. To perform compression tests on various specimens.
3. To perform shear tests on different specimens.
4. To perform hardness tests to determine the hardness of different materials: Rockwell, Brinell and Vicker's hardness.
5. To obtain the impact strength of different metals using Charpy and Izod impact tests.
6. To perform torsion tests on different specimens.
7. To determine buckling loads of long columns with different end connections.
8. To perform bending tests on different materials.

MEC211C Machining Processes Lab 0-0-2

List of Experiments:

1. Study of Machine Tools (Lathe, Shaper, Slotter, Planner) – study the types of cutting tools available and relative motions between cutting tool and work piece on each machine tool.
2. Study of Machine Tools (Grinding, Milling, Drilling) – study the types of cutting tools available and relative motions between cutting tool and work piece on each machine tool.
3. Job making on lathe machine.
4. Job making on shaper /slotter machine.
5. Job making on milling machine.
6. Job making on drilling machine.
7. Job making on grinding machine.
8. Study of various types of cutting tools and measurement of tool geometry (Model making of single point/ multi point cutting tools by rubber/ plastic/ wood etc).
9. To Understand the Effect of Chosen Parameters on the type of chip produced.
10. Determination of chip-thickness ratio and shear plane angle during machining.

MEC260C **Thermo-Fluids Lab** **0-0-2**

List of Experiments:

Applied Thermodynamics:

1. Determination of Flash Point and Fire Point
2. Determination of Dryness Fraction of Steam
3. Flue Gas Analysis
4. Determination of calorific value using Bomb Calorimeter.
5. Study of Various Types of Boilers, Boiler Mountings and Accessories
6. Performance and Energy Balance Test on a Fire Tube/ Water Tube Boiler.
7. Performance of Single Stage/ Multi Stage Reciprocating Compressor
8. Study of Refrigeration System and determination of it's COP.
9. Study of Air Conditioning System
10. Study of cooling tower.

Fluid Mechanics

1. To Study the Flow through a Variable Area Duct and Verify Bernoulli's Energy Equation.
2. To Determine the Coefficient of Discharge for an Obstruction Flow Meter (VenturiMeter/Orifice Meter)
3. To Determine the Discharge Coefficient for Notches And Weirs.
4. To Study the Transition from Laminar to Turbulent Flow and to ascertain Lower Critical Reynolds Number.
5. To Determine the Friction Coefficient for Pipes of Different Diameters.
6. To Determine the Head Loss in a Pipe Line Due to Sudden Expansion/ Sudden Contraction/ Bend.
7. To Determine the Velocity Distribution for Pipeline Flow with a Pitot Static Probe.
8. Flow Visualization
9. Study of fluid flow through wind tunnel.

ELE280C Electrical and Electronics Lab 0-0-2

List of Experiments:

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. To study resonance in series and parallel RLC Circuits.
3. Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line, and phase currents).
5. Measurement of Power in single phase and 3 phase Circuits.
6. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
7. Speed control of DC Motor by using Armature Voltage control and Field or flex control
8. VI characteristics of PN Junction diode
9. Design HW, FW rectifier
10. Plotting output characteristics of transistor
11. Operating of transistor as a switch and an Amplifier.
12. Design of Half adder and Full adder Circuit.

MEC310C Heat Transfer Lab 0-0-2

List of Experiments:

1. Determination of Fin efficiency and effectiveness of a pin fin in forced convection and natural convection
2. Determination of thermal conductivity of a plate by two slab guarded hot plate method
3. Determination of thermal conductivity of pipe insulation and insulation powder
4. Determination of thermal conductivity of a liquid by the guarded hot plate method
5. Determination of thermal conductivity of a good conductor of heat (metal rod)
6. Determination of overall resistance of a composite wall
7. Determination of heat transfer coefficient in forced convection through a horizontal tube
8. Determination of heat transfer coefficient for heat vertical cylinder in natural convection
9. Determination of LMTD and NTU in parallel flow and counter flow heat exchanger
10. Determination of Stefan Boltzmann's constant
11. Determination of Emissivity
12. Demonstration of heat pipe.

MEC311C Manufacturing Processes Lab 0-0-2

List of Experiments:

1. Basic understanding of Different Manufacturing Processes: concepts, application, advantage and future aspects.
2. Hands on Exercise on Pattern Making.
3. Performance on Metal Casting of Simple component.
4. Study of SMAW/ MMAW process.
5. Making of Lap joints / T- Joints at different welding parameters.
6. Study of TIG / MIG welding processes.
7. Making of Butt joint at different welding parameter by TIG.
8. Making of Butt joint at different welding parameter by MIG.
9. Making of Butt joint (16 mm MS rod) by friction welding at different speed.
10. Design a Jig and Fixture for given component.

MEC360C Mechanisms and Vibrations Lab 0-0-2

List of Experiments:

Theory of Machines:

1. To study various types of links and mechanisms and draw the inversions and velocity diagrams of different mechanisms by Graphical Method.
2. To study the operation of various types of brakes and clutches.
3. To study and conduct experiments on different types of governors: Watt Governor, Proell Governor, Porter Governor, Hartnell Governor.
4. To study the basic fundamentals and operation of different types of gears and gear trains.
5. To study the operation of various types of drives, couplings and bearings.
6. To study the operation of different types of cams and follower.
7. To study and perform experiments on the operation of a gyroscope.
8. To conduct experiments on the balancing of rotating and reciprocating masses.

Mechanical Vibrations:

1. To study undamped free oscillations of a simple pendulum and determine the natural frequency of oscillations.
2. To study undamped free vibrations of a spring mass system and to determine the natural frequency of vibrations.
3. To study the free vibration of a damped second order system and determine the frequency of damped vibrations. Also draw decay curve and determine the logarithmic decrement.
4. To study the vibrations of a compound pendulum and determine its radius of gyration.
5. To find the center of percussion of a compound pendulum.
6. To study the torsional vibration of a single rotor shaft system and to determine the natural frequency.
7. To study the forced vibration of damped second order systems and draw load magnification factor v/s frequency and phase angle v/s frequency curves.
8. To determine the radius of gyration of given bar using bifilar suspension.
9. To determine the radius of gyration of disc using trifilar suspension.
10. To study the vibrations of different types of beams.

MEC361C **CAD/CAM Lab** **0-0-2**

List of Experiments:

1. Study and Understand different types of commands used in Modelling and Simulation Packages like SOLID WORKS and ANSYS.
2. Creation of holes, cuts, shafts, chamfers, slots, revolved features, patterns, sweeps, blends etc.
3. Creation of assembly of different machine parts and other assembly operations.
4. Modelling of different types of mechanical components and assemblies using SOLID WORKS. At least 20 components and 15 assemblies should be modelled by the students during the semester.
5. Analysis and Simulation of simple structural problems using ANSYS. At least 10 problems should be analysed by the students during the semester.
6. Study of the structure of a CNC turning centre and CNC machining centre.
7. Part-Programming on CNC machines using G and M codes for Machining given profiles.
8. Computer Assisted Part Programming using APT language.

MEC410C Industrial Engineering Lab 0-0-2

List of Experiments:

1. Ergonomic design of a product, equipment or work environment; at least 05 exercises and sessions.
2. To assemble and dissemble a given product and record the cycle time and draw learning curve of the operator performing the assembly.
3. Draw Out line process chart and two hand flow process charts for the assembly performed in experiment no. 2, and analyse the present method and also suggest improved method/s.
4. Study and draw of flow process charts (some suitable assembly operation)
5. Study and draw multi activity chart of a suitable method and propose better method/s.(Man and machine)
6. Study suitable movements/travel of man, material or equipment, and draw string diagram, travel chart and flow diagrams.
7. To calculate the standard time of a suitable job, using predetermined time standard techniques.

MEC411C Fluid Machines Lab 0-0-2

List of Experiments:

1. Performance Characteristic Tests on Pelton Wheel
2. Performance Characteristic Tests on Francis Turbine
3. Performance Characteristic Tests on Kaplan Turbine
4. Performance Characteristic Tests on Single Stage, Multi Stage Centrifugal Pumps at Constant Speed & at Variable Speed.
5. Performance Characteristic Tests on Axial Flow Pump.
6. Performance Characteristic Tests on Hydraulic Ram.
7. Performance Characteristic Tests on Reciprocating Pump at Constant Speed and at Variable Speed.
8. Performance Characteristic Tests on Gear Pump.
9. Performance Characteristic Tests on Screw Pump.

Annexure VI

Vetted Course Outline for B. Tech. Mechanical Engineering, Batch 2017-2021

(3rd Semester Onwards)

Semester-III

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC201C	Machining Processes	**3**	**0**	**0**	**3**	**3**
2.	MEC202C	Mechanics of Solids	**4**	**0**	**0**	**4**	**4**
3.	MEC203C	Basic Thermodynamics	**3**	**0**	**0**	**3**	**3**
4.	MEC204C	Machine Drawing & Solid Modelling	**1**	**0**	**4**	**5**	**3**
5.	MTH203C	Applied Mathematics for Engineers	**3**	**0**	**0**	**3**	**3**
6.	MEC205C	Fluid Mechanics	**4**	**0**	**0**	**4**	**4**
7.	MEC210C	Mechanics of Solids Lab	**0**	**0**	**2**	**2**	**1**
8.	MEC211C	Machining Processes Lab	**0**	**0**	**2**	**2**	**1**
Total Credits							**22**

Semester-IV

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC250C	Applied Thermodynamics	**3**	**0**	**0**	**3**	**3**
2.	MEC251C	Mechanics of Materials	**3**	**0**	**0**	**3**	**3**
3.	MEC252C	Theory of Machines and Mechanisms	**4**	**0**	**0**	**4**	**4**
4.	MEC253C	Materials Science and Engineering	**3**	**0**	**0**	**3**	**3**
5.	MEC255C	Fundamentals of Dynamics	**3**	**0**	**0**	**3**	**3**
6.	MEC260C	Thermo-Fluids Lab	**0**	**0**	**2**	**2**	**1**
7.	ELE280C	Electrical and Electronics Lab	**0**	**0**	**2**	**2**	**1**
8.	-	Open Elective	**-**	**-**	**-**	**-**	**-**
Total Credits							**18**

Semester-V

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC301C	Heat and Mass Transfer	**4**	**0**	**0**	**4**	**4**
2.	MEC302C	Design of Machine Elements	**3**	**0**	**0**	**3**	**3**
3.	MEC303C	Manufacturing Processes	**3**	**0**	**0**	**3**	**3**
4.	MEC304C	Measurement & Instrumentation	**3**	**0**	**0**	**3**	**3**
5.	STA303C	Probability and Statistics	**3**	**0**	**0**	**3**	**3**
6.	ECE330C	Microcontrollers	**3**	**0**	**0**	**3**	**3**
7.	MEC310C	Heat Transfer Lab	**0**	**0**	**2**	**2**	**1**
8.	MEC311C	Manufacturing Processes Lab	**0**	**0**	**2**	**2**	**1**
9.	MEC312C	Project-I	**0**	**0**	**6**	**90 (Total)**	**3**
10.	-	Open Elective	**-**	**-**	**-**	**-**	**-**
Total Credits							**24**

Semester-VI

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC350C	Advanced Manufacturing Processes	**4**	**0**	**0**	**4**	**4**
2.	MEC351C	Machine Design	**3**	**0**	**0**	**3**	**3**
3.	MEC352C	Mechanical Vibrations	**4**	**0**	**0**	**4**	**4**
4.	MECXXXE	Elective-I (Discipline Centric)	**3**	**0**	**0**	**3**	**3**
5.	XXXXXXG	Elective-II (Generic)	**-**	**-**	**-**	**-**	**X**
6.	MEC360C	Mechanisms & Vibrations Lab	**0**	**0**	**2**	**2**	**1**
7.	MEC361C	CAD/CAM Lab	**0**	**0**	**2**	**2**	**1**
8.	MEC362C	Project-II	**0**	**0**	**8**	**120 (Total)**	**4**
9.	-	Open Elective	**-**	**-**	**-**	**-**	**-**
Total Credits							**20+X**

Semester-VII

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC401C	Hydraulics & Hydraulic Machines	**3**	**0**	**0**	**3**	**3**
2.	MEC402C	Industrial Engineering	**3**	**0**	**0**	**3**	**3**
3.	MTH403C	Numerical Methods in Engineering	**3**	**0**	**0**	**3**	**3**
4.	MECXXXE	Elective-III (Discipline Centric)	**3**	**0**	**0**	**3**	**3**
5.	XXXXXXG	Elective-IV (Generic)	**-**	**-**	**-**	**-**	**X**
6.	MEC410C	Industrial Engineering Lab	**0**	**0**	**2**	**2**	**1**
7.	MEC411C	Fluid Machines Lab	**0**	**0**	**2**	**2**	**1**
8.	MEC412C	Minor Project	**0**	**0**	**8**	**120 (Total)**	**4**
9.	-	Open Elective	**-**	**-**	**-**	-	**-**
Total Credits							**18+X**

Semester-VIII

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC450C	Operations Research	**3**	**0**	**0**	**3**	**3**
2.	MECXXXE	Elective-V (Discipline Centric)	**3**	**0**	**0**	**3**	**3**
3.	XXXXXXG	Elective-VI (Generic)	**-**	**-**	**-**	**-**	**X**
4.	MEC460C	Major Project	**0**	**0**	**24**	**330 (Total)**	**12**
5.	-	Open Elective	**-**	**-**	**-**	-	**-**
Total Credits							**18+X**

MEC255C Fundamentals of Dynamics 3-0-0

Kinematics of Particles: Introduction, Rectilinear Motion, Plane Curvilinear Motion , Rectangular coordinates (x-y), Normal and Tangential coordinates (n-t), Polar coordinates (r-θ), Space curvilinear motion, Relative motion, Constrained particle motion. (Vectorial approach to be adopted)

Kinetics of Particles: Review of Force, Mass, Acceleration, Impulse, Momentum, Work and Energy, Linear impulse and linear momentum, Angular impulse and angular momentum, Impact, Central- Force and motion, and relative motion.

Kinetics of Systems of Particles: Introduction, Generalised Newton's second law, Work-Energy, Impulse-Momentum, Conservation of Energy and Momentum, Steady Mass Flow, Variable mass.

Plane Kinematics of Rigid Bodies: Introduction, Rotation, Absolute Motion, Relative velocity, Instantaneous centre of zero velocity, Relative acceleration, Motion relative to rotating axes.

Plane Kinetics of Rigid bodies: Introduction, General equation of Motion, Translation, Fixed axis rotation, General plane motion, Work energy relations, acceleration from work-energy; virtual work, Impulse-Momentum equation.

Text Books:

1. Meriam, J.L., Kraige L.G., "Engineering Mechanics: Dynamics". S.I. Version, *John Wiley & Sons Inc.*

Reference Books:

1. Shames and Rao, "Engineering Mechanics: Statics and Dynamics", *Pearson Education India; 4th edition.*
2. Hibbeler R.C., "Engineering Mechanics: Statics and Dynamics", *Pearson Education India; 11th edition.*
3. Hibbeler, R.C., "Engineering Mechanics: Dynamics", *Pearson, 13th Edition.*

Annexure VII

Vetted Course Outline for B. Tech. Mechanical Engineering, Batch 2016-2020

(5^{th} Semester Onwards)

Semester-V

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC301C	Heat and Mass Transfer	4	0	0	4	4
2.	MEC302C	Design of Machine Elements	3	0	0	3	3
3.	MEC304C	Measurement & Instrumentation	3	0	0	3	3
4.	STA303C	Probability and Statistics	3	0	0	3	3
5.	ECE330C	Microcontrollers	3	0	0	3	3
6.	MEC310C	Heat Transfer Lab	0	0	2	2	1
7.	MEC313C	Applied Thermodynamics Lab	0	0	2	2	1
8.	MEC312C	Project-I	0	0	6	90 (Total)	3
9.	-	Open Elective	-	-	-	-	-
Total Credits							21

Semester-VI

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC350C	Advanced Manufacturing Processes	4	0	0	4	4
2.	MEC351C	Machine Design	3	0	0	3	3
3.	MEC352C	Mechanical Vibrations	4	0	0	4	4
4.	MECXXXE	Elective-I (Discipline Centric)	3	0	0	3	3
5.	XXXXXXG	Elective-II (Generic)	-	-	-	-	X
6.	MEC360C	Mechanisms & Vibrations Lab	0	0	2	2	1
7.	MEC361C	CAD/CAM Lab	0	0	2	2	1
8.	MEC362C	Project-II	0	0	8	120 (Total)	4
9.	-	Open Elective	-	-	-	-	-
Total Credits							20+X

Semester-VII

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC401C	Hydraulics & Hydraulic Machines	**3**	**0**	**0**	**3**	**3**
2.	MEC402C	Industrial Engineering	**3**	**0**	**0**	**3**	**3**
3.	MTH403C	Numerical Methods in Engineering	**3**	**0**	**0**	**3**	**3**
4.	MECXXXE	Elective-III (Discipline Centric)	**3**	**0**	**0**	**3**	**3**
5.	XXXXXXG	Elective-IV (Generic)	**-**	**-**	**-**	**-**	**X**
6.	MEC410C	Industrial Engineering Lab	**0**	**0**	**2**	**2**	**1**
7.	MEC411C	Fluid Machines Lab	**0**	**0**	**2**	**2**	**1**
8.	MEC412C	Minor Project	**0**	**0**	**8**	**120 (Total)**	**4**
9.	-	Open Elective	**-**	**-**	**-**	**-**	**-**
Total Credits							**18+X**

Semester-VIII

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC450C	Operations Research	**3**	**0**	**0**	**3**	**3**
2.	MECXXXE	Elective-V (Discipline Centric)	**3**	**0**	**0**	**3**	**3**
3.	XXXXXXG	Elective-VI (Generic)	**-**	**-**	**-**	**-**	**X**
4.	MEC460C	Major Project	**0**	**0**	**24**	**330 (Total)**	**12**
5.	-	Open Elective	**-**	**-**	**-**	**-**	**-**
Total Credits							**18+X**