Tripura University
(A Central University)

Curriculum

For

B. Tech in Mechanical Engineering

(3rd to 8th Semester)

2021

Curriculum Structure (Total Credit: 162)

COMMON SYLLABUS- FIRST SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Basic Science - 1	BS 101	Mathematics - I	3	1	0	4	4	100
2.	Basic Science - 2	BS 102	Physics	3	1	0	4	4	100
3.	Engineering Science - 1	ES 103	Basic Electrical Engineering	3	1	0	4	4	100
4.	Engineering Science - 2	ES 104	Engineering Graphics and Design	1	0	0	1	1	100
5.	Basic Science - 3	BS 105	Physics Laboratory	0	0	3	3	1.5	100
6.	Engineering Science - 3	ES 106	Engineering Graphics Practice	0	0	4	4	2	100
7.	Engineering Science - 4	ES 107	Basic Electrical Engineering Laboratory	0	0	2	2	1	100
8.	Mandatory Course - 1	MC 108	Induction Program	3 weeks in the beginning of the semester				0	100
			Total :	**10**	**3**	**9**	**22**	**17.5**	**800**

COMMON SYLLABUS- SECOND SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hours/ week	Credit	Full Marks
1.	Humanities Science - 1	HS 201	English	2	0	0	2	2	100
2.	Basic Science - 4	BS 202	Mathematics-II	3	1	0	4	4	100
3.	Basic Science - 5	BS 203	Chemistry	3	1	0	4	4	100
4.	Engineering Science - 5	ES 204	Programming for Problem Solving	3	0	0	3	3	100
5.	Engineering Science - 6	ES 205	Manufacturing Practices	1	0	0	1	1	100
6.	Humanities Science - 2	HS 206	Language Laboratory	0	0	2	2	1	100
7.	Basic Science - 6	BS 207	Chemistry Laboratory	0	0	3	3	1.5	100
8.	Engineering Science - 7	ES 208	Programming for Problem Solving Lab	0	0	4	4	2	100
9.	Engineering Science - 8	ES 209	Workshop on Manufacturing Practices	0	0	4	4	2	100
10.	Mandatory Course - 2	MC 210	Environmental Science	3	0	0	3	0	100
			Total :	**15**	**2**	**13**	**30**	**20.5**	**1000**

THIRD SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 2	HU 301	Effective Technical Communication	3	0	0	3	3	100
2.	Basic Science - 7	BS 302	Mathematics-III	2	1	0	3	3	100
3.	Basic Science - 8	BS 303	Biology for Engineers	2	0	0	2	2	100
4.	Engineering Science - 5	ES 304	Engineering Mechanics	2	1	0	3	3	100
5.	Program Core - 1	PC ME 305	Thermodynamics	3	0	0	3	3	100
6.	Program Core - 2	PC ME 306	Fluid Mechanics-I	3	0	0	3	3	100
7.	Program Core - 3	PC ME 307	Strength of Materials-I	3	0	0	3	3	100
8.	Program Core - 4	PC ME 308	Thermodynamics Lab	0	0	2	2	1	100
9.	Program Core - 5	PC ME 309	Machine-Shop Practice	0	0	2	2	1	100
10.	Mandatory Course - 3	MC 310	Indian Constitution	2	0	0	2	0	100
			Total :	**20**	**2**	**4**	**26**	**22**	**1000**

4th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 3	HU 401	Engineering Economics and Accountancy	3	0	0	3	3	100
2.	Humanities Science - 4	HU 402	Universal Human Values-II: Understanding Harmony	2	1	0	3	3	100
3.	Program Core - 6	PC ME 403	Thermal Engineering	3	1	0	4	4	100
4.	Program Core - 7	PC ME 404	Fluid Mechanics-II	3	1	0	4	4	100
5.	Program Core - 8	PC ME 405	Strength of Materials-II	3	0	0	3	3	100
6.	Program Core - 9	PC ME 406	Manufacturing Process - I	3	0	0	3	3	100
7.	Program Core - 10	PC ME 407	Strength of Materials Lab	0	0	2	1	1	100
8.	Program Core - 11	PC ME 408	Fluid Mechanics Lab	0	0	2	1	1	100
9.	Program Core - 12	PC ME 409	Manufacturing Lab	0	0	2	1	1	100
10.	Mandatory Course - 4	MC 410	Essence of Indian Knowledge Tradition	2	0	0	2	0	100
			Total:	19	3	6	28	**23**	**1000**

5th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Total Marks
1.	Humanities Science -5	HU 501	Professional Practice, Law and Ethics	2	0	0	2	2	100
2.	Program Core-13	PC ME 502	Heat Transfer	3	0	0	3	3	100
3.	Program Core-14	PC ME 503	Non Conventional Energy Sources	3	0	0	3	3	100
4.	Program Core-15	PC ME 504	Design of Machine Elements	3	0	0	3	3	100
5.	Program Core-16	PC ME 505	Manufacturing Process - II	3	0	0	3	3	100
6.	Program Core-17	PC ME 506	Kinematics and Theory of Machines	3	0	0	3	3	100
7.	Program Core-18	PC ME 507	Heat Transfer Lab	0	0	2	2	1	100
8.	Program Core-19	PC ME 508	Machine Design Sessional	0	0	2	2	1	100
9.	Program Core-20	PC ME 509	Manufacturing Technology Lab	0	0	4	4	2	100
10.	Summer Internship-1	SI ME 510	Industry Internship - I	0	0	0	0	1	100
			Total :	17	0	8	25	**22**	**1000**

6th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Total Marks
1.	Program Core-21	PC ME 601	Fluid Power Engineering	3	0	0	3	3	100
2.	Program Core-22	PC ME 602	Mechanical Vibration	3	0	0	3	3	100
3.	Program Core-23	PC ME 603	Dynamics of Machine	3	0	0	3	3	100
4.	Program Core-24	PC ME 604	Refrigeration and Air Conditioning	3	0	0	3	3	100
5.	Program Core-25	PC ME 605	Mechanical Vibration & Dynamics of Machine Lab	0	0	2	2	1	100
6.	Program Core-26	PC ME 606	Fluid Machines Lab	0	0	2	2	1	100
7.	Program Core-27	PC ME 607	Refrigeration and Air Conditioning Lab	0	0	2	2	1	100
8.	Program Elective-1	PE ME 608/1	1.Internal Combustion Engines	3	0	0	3	3	100
		PE ME 608/2	2. Mechatronics Systems	3	0	0			100
		PE ME 608/3	3. Computer Aided Design	3	0	0			100
9.	Project - 1	PR ME 609	Mini Project	0	0	6	6	3	100
			Total :	15	0	12	27	**21**	**900**

7th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Total Marks
1.	Program Elective-2	PE ME 701/1	1.Power Plant Engineering	3	0	0	3	3	100
		PE ME 701/2	2.Robotics	3	0	0			
		PE ME 701/3	3.Tribology	3	0	0			
2.	Program Elective-3	PE ME 702/1	1.Alternative Fuels	2	0	0	2	2	100
		PE ME 702/2	2.Energy Conservation and Management	2	0	0			
		PE ME 702/3	3 Advanced Casting Processes	2	0	0			
3.	Open Elective-1	OE ME 703	Refer Annexure-I	3	0	0	3	3	100
4.	Open Elective-2	OE ME 704	Refer Annexure-II	2	0	0	2	2	100
5.	Project - 2	PR ME 705	Project Work Intermediate	0	0	12	12	6	200
6.	Summer Internship-2	SI ME -706	Internship - II	0	0	0	0	1	100
7.	Seminar - 1	SE ME 707	Seminar on Contemporary Engineering Topics - I	0	0	2	2	1	100
Total :				10	0	14	24	**18**	**800**

8th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Total Marks
1.	Program Elective-4	PE ME 801/1	1.Welding and Allied Processes	3	0	0	3	3	100
		PE ME 801/2	2.Non-Traditional Machining						
		PE ME 801/3	3.Production Engineering						
2.	Program Elective-5	PE ME 802/1	1.Automobile Engineering	2	0	0	2	2	100
		PE ME 802/2	2.Operation Research						
		PE ME 802/3	3.Gas Dynamics & Jet Propulsion						
3.	Open Elective-1	OE ME 803	Refer Annexure-III	3	0	0	3	3	100
4.	Open Elective-2	OE ME 804	Refer Annexure-IV	2	0	0	2	2	100
5.	Project - 3	PR ME 805	Project Work Final	0	0	12	12	6	200
6.	Seminar - 2	SE ME 806	Seminar on Contemporary Engineering Topics - II	0	0	2	2	1	100
7.	Online Course	SW ME 807	SWAYAM Courses	0	0	0	0	1	100
Total :				10	0	14	24	**18**	**800**

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For

B. Tech in Mechanical Engineering

(3rd Semester)

2021

THIRD SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 2	HU 301	Effective Technical Communication	3	0	0	3	3	100
2.	Basic Science - 7	BS 302	Mathematics-III	2	1	0	3	3	100
3.	Basic Science - 8	BS 303	Biology for Engineers	2	0	0	2	2	100
4.	Engineering Science - 5	ES 304	Engineering Mechanics	2	1	0	3	3	100
5.	Program Core - 1	PC ME 305	Thermodynamics	3	0	0	3	3	100
6.	Program Core - 2	PC ME 306	Fluid Mechanics-I	3	0	0	3	3	100
7.	Program Core - 3	PC ME 307	Strength of Materials-I	3	0	0	3	3	100
8.	Program Core - 4	PC ME 308	Thermodynamics Lab	0	0	2	2	1	100
9.	Program Core - 5	PC ME 309	Machine-Shop Practice	0	0	2	2	1	100
10.	Mandatory Course - 3	MC 310	Indian Constitution	2	0	0	2	0	100
			Total :	**20**	**2**	**4**	**26**	**22**	**1000**

Effective Technical Communication

Course Code	HU 301
Course Title	Effective Technical Communication
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	1st year B.Tech
Course Category	Humanities Science (HS)
Number of classes	36 hours

Course Outcomes:

At the end of the course, the student will be able to -

CO Number	CO Description	K-level
CO-1	Understand the nature and objective of Technical Communication relevantfor the work place as Engineers	K-2
CO-2	Utilize the technical writing for the purposes of Technical Communication and itsexposure in various dimensions.	K-3
CO-3	Develop effective verbal and non-verbal communication skills.	K-3
CO-4	Analyze ethical, legal, cultural, and global issues affecting Technical Communication and Develop appropriate life skills.	K-4

Module 1: Essentials of Communication(09 hrs)

What is Communication, Process of Communication, Levels of communication, The flow of Communication: Downward, Upward, Lateral or Horizontal (Peer group) Communication Barriers to communication, Non-verbal Communication, , Technology Enabled communication, Impact of Technology, Selection of appropriate communication Technology, Importance of Technical Communication, Differences between general and technical communication.

Module 2: Technical Writing Skills (09 hrs)

Technical writing process – Choosing right words, phrases and sentence patterns, clarity of purpose, planning content, effective style of writing, formatting, proofreading.
Technical Reports & Proposals: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; Writing of Reports & Proposals.
Business letters:Sales & Credit letters; Claim and Adjustment Letters; Letters of Enquiry, Order Placement letters.
Email Writing: Reasons for popularity; guiding principles for composition; some common pitfalls; maintaining common etiquette.

Module: 3 Workplace Communication (09 hrs)

Applying for a job: Skimming advertisements; Writing job applications; Preparing CV, Resume.
Group Discussions: Group Discussion types; GD as a part of selection process; Key skills to succeed in group discussions; Dos and Don'ts of group discussions; Use of body language in GDs.

Job Interviews: Objectives; Types; Stages of Interview, Face to face Interviews; Telephonic Interviews.
Effective Business Presentations: Importance in workplace communication; Planning, Preparing, Organizing, Rehearsing, and Delivering Oral presentations, Handling Questions; Visual aids in presentations; Power Point Presentations
Ethics in Communication: Communication challenges in culturally diverse workforce;Bias-free communication

Module: 4 Developing soft skills/ Life Skills (09 hrs)

Introduction to soft skills: Soft skills as a competitive weapon in today's changing workplace.
Classification of soft skills: Time management, Attitude, Responsibility, Ethics & Values, self-confidence, Teamwork and Interpersonal skills, Problem solving skills.
Personality Development: Developing Right personality to enhance Life Skills, Personality types; Personality attributes; and Leadership Qualities.
Body Language : Emotions displayed by body language:Aggressive,Submissive,Attentive,Nervous,Upset,Bored, Relaxed, Defensive; Hand Shake; Eye Contact; Posture and Positioning.
Personality traits and soft skills in early stages of career advancement and for future career advancement.

List of Software/Learning Websites

1. http://www.free-english-study.com/
2. http://www.english-online.org.uk/course.htm
3. http://www.english-online.org.uk/
4. http://www.talkenglish.com/
5. http://www.learnenglish.de/

References / Suggested Learning Resources:-

1) Sanjay Kumar &PushpLata Communications Skills , 2nd Edition,Oxford University Press
2) Meenakshi Raman & Sangeeta Sharma Technical Communication: Principles & Practice Oxford University Press
3) Barun Kumar Mitra, Personality Development and Soft Skills Oxford University Press.
4) Personality Development, Harold R. Wallace & L. Ann Masters, Cengage Learning, NewDelhi.
5) Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
6) Communication Skills for Engineers and Scientists, Sangeeta Sharma et.al. PHI Learning Pvt. Ltd, 2011, New Delhi.
7) Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, McGraw Hill & Co. Ltd., 2001, New Delhi.
8) A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.
9) Skills for Effective Business Communication by Michael Murphy, Harward University, U.S

Mathematics-III

Course Code	BS 302
Course Title	Mathematics-III
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	B.Tech 1st Year Mathematics
Course Category	Basic Science (BS)
Number of classes	36 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Solve problems in 1st and 2nd order linear Partial Differential Equations.	K-3
CO-2	Showfourier series expansion of a given function and solve PDEs by variables separable method.	K-3
CO-3	Identify mean and variance of a given probability distribution.	K-3
CO-4	Solve numerically algebraic/transcendental equation and ordinary differential equations.	K-3

Course Content:-

Module 1: Partial Differential Equations (10hrs)

First order partial differential equations, solutions of first order linear and quasi-linear partial differential equation (Pp + Qq =R) by Lagrange method. Homogeneous and non-homogeneous type of second order linear differential equation with constant coefficients by complimentary function and particular integral method.

Module 2: Fourier series(08 hrs)

Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions. One-dimensional wave equation and one-dimensional heat flow equation - method of separation of variables - Fourier series solution.

Module 3: Probability (08hrs)

Classical and axiomatic definition of probability, conditional probability, Bayes' theorem, independent events, random variables, expectation and higher order moments, probability mass function and probability density function, distribution function, Sample space, Events, Random Variables; Definitions of probability, conditional Probability, examples of discrete and continuous distributions: Normal, Poisson, Binomial distributions.

Module 4: Numerical Analysis (10hrs)

Numerical solution of algebraic and transcendental equations by Regula-Falsi method Newton-Raphson's method; Finite Differences - Newton's Forward, backward difference interpolation formulae - Lagrange interpolation; Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule; Solving

first order differential equations –Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta method of 4th order.

References / Suggested Learning Resources:-

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 1965.
2. Rajnish Verma & H.K. Dass, Higher Engineering Mathematics, S Chand, 2014.
3. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993
4. Jain, Iyengar and Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publications, 2008.
5. Erwyn Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.

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Biology for Engineers

Course Code	BS-303
Course Title	Biology for Engineers
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	-
Course Category	Basic Science (BS)
Number of classes	26 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Demonstrate the understandingof biology and its branches, major classifications of life,Cells, Cellular systems their functions and biological molecules.	K-2
CO-2	Illustrate the molecular basis of genetic information and the flow of genetic information from DNA to RNA to protein and the concept of mutations, re-combinations and its applications.	K-2
CO-3	Classify microorganisms, growth, nutrition with their various methods used for the isolation, identification, control and maintenance of microbial cultures.	K-4
CO-4	Explain the fundamental principles of energy transactionsin physical and biological and physiological systems, basic metabolisms.	K-2

Course Content:

Module 1: Introduction to Biology, Classification andBiomolecules (8 hours)

Detailed content of the module: Introduction to Biology and its branches. Molecular taxonomy- three major kingdoms of life. Prokaroytic and Eukaryotic cells. Energy and Carbon utilization. Cells: Animal and Plant cell structures and functions. Cell cycle and Cell division. Transport across cell membrane. Cell signaling. Molecules of life. Monomeric units and polymeric structures. Sugars, starch and cellulose. Lipids, Amino acids and proteins. Nucleotides, DNAand RNA. Proteins- structure and function. Proteins as enzymes,

transporters, receptors and structural elements. Enzyme classification. Mechanism of enzyme action. Enzyme kinetics.

Module 2: Fundamentals of genetics and flow of informations (6 hours)

Detailed content of the module: General principles of genetics, Concept of segregation and independent assortment.Molecular basis of information transfer, molecular basis of coding and decoding genetic information. DNA as genetic material. Concept of genetic code. Define gene in terms of complementation and recombination. Mutation. Recombinant DNA technology.Gene mapping. Application of recombinant DNA technology, recombinant products available in the market and at laboratory scale.

Module 3: Microbiology and applications (6 hours)

Detailed content of the module: Microorganisms and environment: Identification and classification of microorganisms. Ecological aspects of single celled organisms.Microbial integrations.Growth, nutrition and reproduction. Growth kinetics.Isolation and identification of microorganisms. Pure cultures and their characteristics. Maintenance of cultures. Sterilization.Physical and chemical methods of control of microorganisms. Management of toxic industrial wastes.

Module 4:Fundamentals of energy transaction and metabolism (6 hours)

Detailed content of the module: Thermodynamics –laws and its application in biological systems. Energy yielding and energy consuming biochemical processes.
Metabolism- Glycolysis & Krebs cycle, Role of ATP and concept of energy change. Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system.
Fundamental aspects of analysis of living systems; quantitative aspects of physiology and engineering applications to clinical medicine based on body fluid balance, solute transport, basic endocrinology, reproduction physiology, neurophysiology, skeletal and smooth muscle physiology.

References / Suggested Learning Resources:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.;Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd. 12th Edition, 2020
2. Guyton and Hall, Medical Physiology, 14th Edition, Elsevier Saunders, 2020.
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman andCompany.
4.Principles of Genetics, D. Peter Snustad and Michael J. Simmons. 7th Edition, Wiley Publisher, 2015
5. Prescott's Microbiology, Joanne Willey and Kathleen Sandman and Dorothy Wood, 2020. 11th Edition McGraw Hill.

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Engineering Mechanics

Course Code	ES 304
Course Title	Engineering Mechanics
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	---
Course Category	Engineering Science (ES)
Number of classes	36 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Differentiate coplanar, concurrent & non-concurrent forces and their resultants and confidently tackle equilibrium equationsand its applications.	K3
CO-2	Explain centroid of simple figures, centre of gravity, moment of inertia of composite sections & mass moment of inertia of circular plates, cylinder, cone, sphere & hook.	K2
CO-3	Analyze simple truss, compound truss, frame & virtual work.	K4
CO-4	Understand and be able to apply other basic dynamics concepts - the Work-Energy principle, analyze D'Alembert's principle and differentiate longitudinal, transverse, torsional and damped vibrations.	K2

Course Content:-

Module 1: Fundamentals of Engineering Mechanics*:*(9hours)

-Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particleequilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces,Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant ofForce System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium ofCoplanar Systems and Spatial Systems; Static Indeterminacy

-Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack;

Module 2: Centre of Gravity & Moment of Inertia:(9hours)

-Centroid and Centre of Gravity covering, Centroid of simple figures from first principle,centroid of composite sections; Centre of Gravity and its implications;

-Area moment of inertia-Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia,Moment of inertia of standard sections and composite sections; Mass moment inertia of circularplate, Cylinder, Cone, Sphere, Hook.

Module 3: Trusses, Frames & Virtual Work :(9hours)

-Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections;Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zeroforce members; Beams & types of beams; Frames & Machines;

-Virtual Work and Energy Method- Virtual displacements, principle of virtual work for

particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational),energy equation for equilibrium. Applications of energy method for equilibrium. Stability ofequilibrium.

Module 4: Dynamics& Mechanical Vibrations :(9hours)
-Dynamics - Basic terms & General principles of dynamics, Types of motion, Instantaneous centre of rotation in plane motion, D'Alembert's principle and its application, Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.

-Vibration - Basic concepts of Longitudinal, Transverse and Torsional vibrations, Free & Forced vibration, Resonance and its effects, Damped vibration.

Text Books / References:
1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford UniversityPress
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
7. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
8. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
9. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
10. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications
11.Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education.
12.Irving, H.Shames, Engineering Mechanics-Statics and Dynamics, by Prentice-Hall of India.
13.Khurmi R. S. (2010), Engineering Mechanics, S. Chand & Co.
14.NPTEL web or video courses on Engineering Mechanics.
15.Timoshenko & D.H.Young, Engineerring Mechanics,Tata McGraw-Hill publishing Co. Ltd.

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Thermodynamics

Course Code	PCME 305
Course Title	Thermodynamics
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	NIL
Course Category	Program Core (PC)
Number of classes	38 hours

Course Outcome:
After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Apply energy balance to systems andcontrol volumes, in situations involving heat and work interactions	K3

CO-2	Interpret the behavior of pure substances and its application in practical problems.	K2
CO-3	Illustrate the second law of thermodynamics and basic thermodynamic cycles	K3
CO-4	Apply the knowledge of entropy, reversibility, irreversibilityand exergy to solve numerical problems	K3

Course Content:

Module 1: Fundamentals: (10 hours)

System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property;Various modes of energy, Internal energy and Enthalpy.

Module 2: Pure Substances&First Law for Flow Processes: (12 hours)

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures,Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties,Mollier's chart.
Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

Module 3: Second law &Thermodynamic cycles: (8 hours)

Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.
Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycleand comparison with Carnot cycle.

Module 4: Entropy, Availability & Irreversibility: (8 hours)

Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; of s from steam tables-Principle of increase of entropy; Illustration of processes in Ts coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles-Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.

References / Suggested Learning Resources:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co.Ltd.
5. Yunus A.Cenegal and Michael A.Boles, 2002, *Thermodynamics- An Engineering Approach,* Tata McGraw Hill publications

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FLUID MECHANICS-I

Course Code	PC ME-306
Course Title	Fluid Mechanics-I
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Engineering Physics and Mathematics
Course Category	Program Core (PC)
Number of classes	36 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Explain fluid properties and fluid pressure.	K2
CO-2	Solve problems related to hydrostatics and fluid kinematics.	K3
CO-3	Analyze basic principles related to fluid dynamics.	K4
CO-4	Evaluate basic principles related to laminar flow and turbulent flow.	K5

Course Content:

Module 1: Properties of fluids and fluid pressure: (06 hours)

Mass and weight density, specific gravity, specific volume, viscosity and Newton's law of viscosity, Compressibility, Types of fluid, surface tension and capillarity.

Fluid pressure at a point and Pascal's law, absolute, gauge and vacuum pressures, pressure variation in a fluid at rest, pressure measurement, Manometers and Mechanical Gauges.

Module 2: Hydrostatics and fluid kinematics: (10 hours)

Total pressure and centre of pressure for various plane surfaces and curved surfaces submerged in liquid. Buoyancy, center of buoyancy, metacentre and metacentric height and equilibrium of floating bodies, period of oscillation.

Kinematics of flow: Types of fluid flow, continuity equation in three dimensions, velocity potential function and stream function, forced and free vortex flow.

Module 3: Fluid dynamics (10 hours)

Euler's equation and Bernoulli's equation, application of Bernoulli's equation-venturimeter, orifice-meter, and pitot tube.

Flow through orifices, hydraulic coefficients, time of emptying hemispherical and horizontal cylindrical tank through an orifice at it's bottom. Discharge over rectangular, triangular and trapezoidal notches, velocity of approach.

Module 4: Laminar and turbulent flow (10 hours)

Flow of viscous fluid through circular pipe-velocity distribution and average velocity, Hagen Poiseiulle formula, Kinetic energy correction and Momentum Correction factors, Navier-Stokes equation of motion.

Reynold's experiment, Loss of head due to friction in pipes, Reynold's expression and Prandtl mixing length theory for turbulent shear stress.

References / Suggested Learning Resources:

1. Som, S. K., & Biswas, G. Introduction to fluid mechanics and fluid machines: Tata McGraw-Hill.

2. Cengel, Y., Fluid Mechanics, Tata McGraw-Hill.
3. Bansal, R. K. A textbook of fluid mechanics and hydraulic machines, Laxmi Pub.
4. Rajput, R.K., A Textbook of Fluid Mechanics and Fluid Machines, S. Chand Pub.
5. Kumar, D.S., Fluid Mechanics and Fluid Power Engineering, S.K.Kataria& Sons.
6. NPTEL courses: http://nptel.iitm.ac.in/courses.php - web and video resources on Fluid Mechanics.

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Strength of Materials-I

Course Code	PC ME 307
Course Title	Strength of Materials-I
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	---
Course Category	ProgramCore (PC)
Number of classes	36 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Explain the concept of simple stress and strain and different elastic constants.	K2
CO-2	Calculate the principle stresses by both analytical method and graphical method .	K3
CO-3	Draw the S.F. and B.M diagram for beams under different loading conditions.	K4
CO-4	Design simple bending stress and Flexural Stresses.	K4

Course Content:-

Module 1:Concept of stress and strain: (8 hours)

Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains , stress and strain diagram, elongation-stresses and strains in bars subjected to axial loading, Modulus of elasticity, stress produced in compound bars subjected to axial loading. Thermal stress and strain, calculations due to applications of axial loads and variation of temperature in single and compound walls.

Module 2:Compound Stresses and Strains (8 hours)

Compound Stresses and Strains- Two dimensional stress-strain system.Principle planes and principle stresses, methods for determining stresses on oblique section, Analytical method, Graphical method, Mohr's circle, use of Mohr's circle to find Principle stresses.

Module 3:Shear Force and Bending Moment diagrams: (10 hours)

Shear force (SF) and Bending moment (BM) diagrams. SF and BM diagrams for cantilevers, simply supported and fixed beams with or without overhangs. Calculation of maximum BM and SF and the point of contra flexure under concentrated loads, uniformly distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.

Module 4:Theory of bending stresses: (10 hours)

Assumptions in the simple bending theory, derivation of formula: its application to beams of rectangular, circular and channel sections, Composite beams, bending and shear stresses in composite beams. Flexural Stresses- Theory of simple bending – Assumptions – Derivation of bending equation: M/I = f/y = E/R - Neutral axis – Determination of bending stresses – Section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections.

References/ Suggested Learning Resources:-

1. Pytel A H and Singer F L, Strength of Materials, Harper Collins.
2. Dr. R K Bansal, Strength of Materials, Laxmi Publications (P) Ltd.
3. Timoshenko S P and Young D H, Elements of Strength of Materials, East West Press.
4. Beer P F and Johston (Jr) E R, Mechanics of Materials: SI Version, McGraw Hill.
5. Shames, I. H., Pitarresi, J. M., Introduction to Solid Mechanics, Prentice-Hall.
6. Khurmi, R.S., Strength of Materials, S.Chand and Co, Revised edition.
7. NPTEL courses, http://nptel.iitm.ac.in/courses.php, web and video courses on Strength of Materials by Prof. Sharma, S. C., and Prof. Harsha, S. P.
8. Nash W., Strength of Materials Schaum's out line series, Mc Graw Hill.
9. Subramanian, R., Strength of Materials, Oxford University Press, New Delhi.
10. Punmia, Mechanics of Materials, Laxmi Publications.

ThermodynamicsLab

Course Code	PC ME 308
Course Title	Thermodynamics Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Thermodynamics
Course Category	Program Core (PC)
Number of classes	24 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Implementthermodynamic cycles in thermal system.	K3
CO-2	Execute the Heat Pump and Calorimeter.	K3
CO-3	Test Joule's apparatus.	K4
CO-4	Perform in reciprocating compressors and nozzle.	K3

Course Content:

List of experiments

1. Demonstrationof Open cycle and Closed cycle thermal system.
2. Determination of the COP of the Heat Pump.
3. Demonstrationof Bomb Calorimeter.

4. Performing experiments using Throttling Calorimeter.
5. Performing Joule's Experiment.
6. Demonstrationof Gas cycle and calculation of its efficiency.
7. Demonstrationof CD Nozzle and determination of its efficiency
8. Performing experimentsin Air Compressor and analyzingits principles with Laws of Thermodynamics.

References / Suggested Learning Resources:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India.
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co.Ltd.
5. YunusA.Cenegal and Michael A.Boles, 2002, *Thermodynamics- An Engineering Approach,* Tata McGraw Hill publications.

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Machine-shop Practice

Course Code	PC ME 309
Course Title	Machine-shop Practice
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	---
Course Category	ProgramCore (PC)
Number of classes	24 hours

Course Outcome:-

After completion of the course, students will be able :

CO No	CO Description	K-level
CO-1	To perform metal cutting operations on Lathe on a given metal rod to obtain any model	K3
CO-2	To perform milling operations on Milling Machine on a given specimen to obtain any model	K4
CO-3	To perform shaping operations on Shaper Machine on a given specimen to obtain a job.	K3
CO-4	To perform grinding operations on Grinding Machine on a given job to obtain a finished job.	K4
CO-5	To perform welding operations to fabricate metallic job.	K4

List of Experiments *(Minimum 6 experiments to be performed).*

Sl. No.	**Practical Exercises**
1.	To perform simple turning operation on Lathe on a given metal rod to obtain a model
2.	To perform taper turning operation on Lathe on a given metal rod to obtain a model
3.	To perform drilling operation on Lathe on a given job
4.	To perform shaping operation on Lathe on a given circular rod to obtain a square rod

5.	To perform milling operations on Milling Machine on a given specimen to obtain any model
6.	To perform indexing operations on Milling Machine on a given specimen to obtain any model
7.	To perform shaping operations on Shaper Machine on a given specimen to obtain a job.
8.	To perform grinding operations on Grinding Machine on a given job to obtain a finished job.
9.	To perform welding operation on Manual Metal Arc Welding (MMAW) for developing the desired welded joint.
10.	To perform welding operation on Submerged Arc Welding (SAW) for developing the desired welded joint.

References/ Suggested Learning Resources:-

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.
3. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India,1998. 5. Rao P.N., "Manufacturing Technology"

Indian Constitution

Course Code	MC 310
Course Title	Indian Constitution
Number of Credits	0 (L: 2, T: 0, P: 0)
Prerequisites	Nil
Course Category	Mandatory Course (MC)
Number of classes	25 hours

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Explain about framing and nature of Indian Constitution.	K2
CO-2	Identify the fundamental rights and duties of individual and demonstrate the knowledge on Directive Principles of State Policy.	K3
CO-3	Outline the Federal Structure, Centre- State relation, Union Executive and Amendment Procedure	K2
CO-4	Demonstrate the meaning of local self govt., types of local self govt. in rural and urban areas.	K2

Course Content:

Module 1: Constitutional Framework (05 hours)

1. Meaning of Constitutional Law and Constitutionalism.
2. Historical perspective of the Constitution of India.
3. Salient features of the Constitution of India.

Module 2: Fundamental Rights, Duties and Directive Principles of State Policy (06 hours)

1. Fundamental Rights- Articles 14, 19 and 21.
2. Fundamental Duties.
3. Directive Principles of State Policy; Its Legal Status and Significance

Module 3: Nature of India's Political system (07 hours)

1. Federal structure, Distribution of Legislative and Financial Powers between the Union and States.
2. Parliamentary Form of Government- Powers and Position of President of India.
3. Emergency Provisions.
4. Amendment Procedures of the Constitution of India.

Module 4: Rural and Urban Local Self Govt. (07 hours)

1. 73rd Amendment of the Constitution and Panchayati Raj Institutions.
2. 74th Amendment of the Constitution and Urban Local Self Govt. (Municipal Corporation, Municipal Council and Nagar Panchayat).
3. TTAADC.

References / Suggested Learning Resources:

1. Fadia, B.L- "Indian Govt. and Politics"Sahitya Bhawan, Agra.
2. D.D.Basu- "An introduction to the Constitution of India"Lexis Nexis publichers.
3. M.V.Pylee- "Constitutional Govt. in India"S.Chand and Company Ltd.
4. S.C.Kashyap(ed)- "Perspectives on the constitution"Shipra Publication.
5. B.K. Sharma- "Introduction to the Constitution of India"Prentice Hall India Private Ltd.
6. Bhattacharya, D.C. and Banerjee, Malay- "Indian Govt. and Politics"Vijaya Publishing House
7. J.C. Johari- "Indian Govt. and Politics" (2 vols)
8. Das Nityananda- "Grassroot Democracy and Panchayati Raj in Tripura" Progressive Publichers

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Tripura University
(A Central University)

Curriculum

For

B. Tech in Mechanical Engineering

(4th Semester)

2021

4th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 3	HU 401	Engineering Economics and Accountancy	3	0	0	3	3	100
2.	Humanities Science - 4	HU 402	Universal Human Values-II: Understanding Harmony	2	1	0	3	3	100
3.	Program Core - 6	PC ME 403	Thermal Engineering	3	1	0	4	4	100
4.	Program Core - 7	PC ME 404	Fluid Mechanics-II	3	1	0	4	4	100
5.	Program Core - 8	PC ME 405	Strength of Materials-II	3	0	0	3	3	100
6.	Program Core - 9	PC ME 406	Manufacturing Process - I	3	0	0	3	3	100
7.	Program Core - 10	PC ME 407	Strength of Materials Lab	0	0	2	1	1	100
8.	Program Core - 11	PC ME 408	Fluid Mechanics Lab	0	0	2	1	1	100
9.	Program Core - 12	PC ME 409	Manufacturing Lab	0	0	2	1	1	100
10.	Mandatory Course - 4	MC 410	Essence of Indian Knowledge Tradition	2	0	0	2	0	100
			Total:	19	3	6	28	**23**	**1000**

Engineering Economics and Accountancy

Course Code	HU 401
Course Title	Engineering Economics and Accountancy
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Humanities Science (HS)
Number of classes	38 hours

Course Outcomes:

At the end of the course, the student will be able to

CO Number	CO Description	K-level
CO-1	Understand the importance of engineering economics in business.	K-2
CO-2	Demonstrate the necessary knowledge and skills for running a business organisation.	K-2
CO-3	Understand the financial statement and position of an organisation.	K-2
CO-4	Analyze the accounting information for decision making.	K-4
CO-5	Develop the knowledge & skill on business and management.	K-3

Course Content:

Module 1: Engineering economics (9 hrs)

- Engineering economy and its importance;
- Demand & supply: Wants, satisfaction of wants, demand, supply, elasticity of demand, estimation of demand, supply chain economy;
- Production-Factors of production (land, labor, capital, and entrepreneurship), Laws of return.
- Money – Value of money, quantity theory; inflation and deflection.

Module 2: Business Skills for Engineers (9 hrs)

- Business Structure: Proprietorship, Partnership and Joint Stock Company;
- Basic management for businesses: Basic functions of management,
- Risk Management: Type of risk, Risk management steps
- Entrepreneur and Leadership: Leadership styles, Qualities of a good leader for a business;
- Financing and the business: Objectives and sources of funds;
- Taxation: Basics of Income tax & Goods and Services Tax (GST)

Module 3: Financial Accounting for Business (10 hrs)

- Transactions: Financial event, Features of transactions; Recording of transactions;
- Basic accounting: Ledger, Trail balance, Cash book (double column only);

- Final account: Objectives, Preparation of final accounts (Trading A/C, Profit & Loss A/C and Balance Sheet).

Module 4: Managerial Accounting for Decision-making (10 hrs)

- Cost classifications – Material cost control, labor cost control and overhead cost control (only theory);
- Cost sheet: Objective and preparation of Cost sheet (Basic problem);
- Capital budgeting: Objectives Pay-back period and NPV method for feasibility testing of investment
- Working capital management: Factors and sources of WC
- Ratio analysis: Interpretation for industrial control, Basic ratios- Current Ratio, Debt-equity ratio, proft ratio

References / Suggested Learning Resources:

- Fundamentals of Engineering Economics, 4th Edition, by Chan S. Park, Pearson Publishing;
- Engineering Economics And Financial Accounting Paperback, by Arasu, Scitech publication
- Engineering Economics and Financial Accounting for Anna University Paperback by A. Bagad,Technical Publications;
- Financial Management- An analytical framework , Nayak & Manna, Parul Library;
- Principles of Management, Ghose and Basu,ABS Publishing House;

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Universal Human Values-II: Understanding Harmony

Course Code	HU-402
Course Title	Universal Human Values-II: Understanding Harmony
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	Induction Programme and Universal Human Values -I
Course Category	Humanities Science (HS)
Number of classes	36 hours

Course Outcome:At the end of the course, the student will be able to

CO Number	CO Description	K-level
CO-1	Explain the term self-exploration and its application for self-evaluation and development.	K-2
CO-2	Identify the holistic perception of harmony at level of self, family, society, nature and explain it by various examples.	K-3
CO-3	Illustrate the role of a human being in ensuring harmony in society and nature.	K-2

CO-4	Distinguish between ethical and unethical practices, and start identifying a strategy to actualize a harmonious environment wherever they work.	K-4

Module1:CourseIntroduction-Need,BasicGuidelines,ContentandProcess for ValueEducation(8 Hrs)

Self-Exploration–whatisit?-Itscontentandprocess;'NaturalAcceptance'andExperientialValidation-astheprocessforself-exploration.
ContinuousHappinessandProsperity-AlookatbasicHuman Aspirations.
Rightunderstanding,RelationshipandPhysicalFacility-
thebasicrequirementsforfulfillmentofaspirationsofeveryhumanbeingwiththeircorrectpriority.
Understanding Happiness and Prosperity correctly- A critical appraisal of thecurrentscenario.
Methodtofulfilltheabovehumanaspirations:understandingandlivinginharmony atvariouslevels.

Module2:UnderstandingHarmonyintheHumanBeing(10 Hrs)

Understanding humanbeingasaco-existenceofthesentient'I'andthematerial'Body'.
UnderstandingtheneedsofSelf('I')and'Body'-happinessandphysicalfacility.
UnderstandingtheBodyasaninstrumentof'I'(Ibeingthedoer,seerand enjoyer).
Understandingthecharacteristicsandactivitiesof'I'andharmonyin'I'.
Understanding values in human-human relationship; meaning of Justice(nine universal values in relationships) and program for its fulfillment toensuremutualhappiness;TrustandRespectasthefoundationalvaluesofrelationship.
Understanding the meaning of Trust; Difference between intention andcompetence
Understanding the harmony in the society (society being an extension offamily): Resolution, Prosperity, fearlessness (trust) and co-existence ascomprehensiveHumanGoals.

Module 3: Understanding Harmony in the Nature and Existence - Wholeexistenceas Coexistence (8Hrs)

Understanding the harmony in the Nature Interconnectedness and mutual fulfillment among the four orders ofnature-recyclabilityandself-regulationinnature.
Understanding Existence as Co-existence of mutually interacting unitsinall-pervasivespace.
Holisticperceptionofharmonyatalllevelsofexistence.

Module4:ImplicationsoftheaboveHolisticUnderstandingofHarmonyonProfessionalEthics(10 Hrs)

Naturalacceptanceofhumanvalues.DefinitivenessofEthicalHumanConduct.
BasisforHumanisticEducation,HumanisticConstitutionandHumanisticUniversal
Order.Competenceinprofessionalethics:
a.Ability to utilize the professional competence for augmenting universal human order

b.Ability to identify thescopeandcharacteristicsofpeoplefriendlyandeco friendlyproductionsystems,
c.Abilitytoidentifyanddevelopappropriatetechnologiesandmanagementpatternsfor above production systems.

References / Suggested Learning Resources:

1.HumanValuesandProfessionalEthicsbyRRGaur,RSangal,GPBagaria, ExcelBooks,New Delhi,2010

2.Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan,Amarkantak, 1999.

3. HumanValues,A.N.Tripathi,NewAgeIntl.Publishers,NewDelhi,2004.

4. TheStoryofMyExperimentswithTruth-byMohandasKaramchandGandhi.

5. BharatMeinAngrejiRaj-PanditSunderlal

6.RediscoveringIndia-byDharampal

7.HindSwarajor Indian HomeRule- by MohandasK.Gandhi

8.IndiaWinsFreedom-MaulanaAbdulKalamAzad

9.Vivekananda-RomainRolland(English)

10.Gandhi-RomainRolland(English)

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Thermal Engineering

Course Code	PC ME 403
Course Title	Thermal Engineering
Number of Credits	4 (L: 3, T: 1, P: 0)
Prerequisites	Thermodynamics
Course Category	Program Core (PC)
Number of classes	48 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Distinguish fuels and comprehend Air standard cycles.	K2
CO-2	Asses the refrigeration cycles and pschyrometry.	K3
CO-3	Articulate and test nozzle, diffuser theoretically.	K4
CO-4	Evaluate reciprocating compressors and steam turbines.	K5

Course Content:

Module 1: Fuels and Air standard cycles:(14 hours)

Introduction to solid, liquid and gaseous fuels–Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy.

Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat.

Module 2: Vapor power cycles, refrigeration cycles and pschyrometry:(14 hours)
Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Supercritical and ultra super-critical Rankine cycle- Gas power cycles, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.

Module 3: Basics of compressible flow, nozzle and diffuser: (10 hours)
Basicsof compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle,supersaturation, compressible flow in diffusers, efficiency of nozzle and diffuser.

Module 4: Compressors and steam turbines: (10 hours)

Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors. Analysis of steam turbines, velocity and pressure compounding of steam turbines.

References / Suggested Learning Resources:
1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India.
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co.Ltd.
5. YunusA.Cenegal and Michael A.Boles, 2002, *Thermodynamics- An Engineering Approach,* Tata McGraw Hill publications.

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FLUID MECHANICS-II

Course Code	PC ME-404
Course Title	Fluid Mechanics-II
Number of Credits	4 (L: 3, T: 1, P: 0)
Prerequisites	Engineering Physics & Mathematics and Fluid Mechanics-I
Course Category	Program Core (PC)
Number of classes	48 hours

Course Outcome:
After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Describe various losses associated with flow through pipes andexplain dimensions for fluid properties, model laws	K2
CO-2	Solve problems related to flow in open channel	K3
CO-3	Explain boundary layer theory and forces on submerged bodies.	K4

CO-4	Evaluate basic principles and problems related to compressible flow and gas dynamics.	K5

Course Content:

Module 1: Flow through pipes, dimensions and models: (10 hours)

Major and minor losses of energies in pipes, Hydraulic gradient and total energy lines, flow through pipes in series, equivalent pipe, Flow through parallel pipes, Power transmission through pipes and nozzles, water hammer.

Dimensions of fundamental and derived quantities, Dimensional Homogeneity,Simlitude, dimensionless, Model Laws, classification of models.

Module 2: Flow in open channel: (10 hours)

Uniform flow through open channels, Chezy's formula, Most economical sections of channel. Non-uniform flow-specific energy and specific energy curve, critical depth and critical velocity, minimum specific energy, hydraulic jump.

Module 3: Boundary layer theory, drag and lift: (14 hours)

Laminar and Turbulent boundary Layer thickness, Vonkarman's momentum equation, Total drag due to Laminar and turbulent layers on flat plate, separation of boundary layer and it's control.

Drag and lift on a stationary body by flowing fluid, expression for drag and lift and dimensional analysis, stream lined and Bluff bodies, Drag on a sphere and cylinder, Terminal velocity of a body, lift on a airfoil.

Module 4: Compressible flow: (14 hours)

Introduction to Compressible flow,Thermodynamic relations, continuity equation, Bernoulli's equation and momentum equation, velocity of sound in fluid, Mach no. propagation of pressure waves in a compressible fluid-Mach angle, zone of action and silence, stagnation properties, Area-velocity relationship for compressible flow, flow of compressible fluid through nozzles maximum mass flow rate and it's variation, mass flow rate of compressible fluid through venturimeter, pito-static tube. Normal and oblique shock waves.

References / Suggested Learning Resources:

1. Som, S. K., & Biswas, G. Introduction to fluid mechanics and fluid machines: Tata McGraw-Hill.
2. Cengel, Y., Fluid Mechanics, Tata McGraw-Hill.
3. Bansal, R. K. A textbook of fluid mechanics and hydraulic machines, Laxmi Pub.
4. Rajput, R.K., A Textbook of Fluid Mechanics and Fluid Machines, S. Chand Pub.
5. Kumar, D.S., Fluid Mechanics and Fluid Power Engineering, S.K.Kataria& Sons.
6. NPTEL courses: http://nptel.iitm.ac.in/courses.php - web and video resources on Fluid Mechanics.

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Strength of Materials-II

Course Code	PC ME 405
Course Title	Strength of Materials-II
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	---
Course Category	ProgramCore (PC)
Number of classes	36 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Explain effects of slope and deflection on beams and design beams considering slope and deflection.	
CO-2	Design a part subjected to the torsion.	
CO-3	Design simple thick and thin cylinders.	
CO-4	Design column and struts under different loading condition.	

Module 1:Slope and deflection: (9 Hrs.)
Introduction ,Deflection and slope of a beam subjected to bending Moment, relation between slope ,deflection and radius of curvature deflection of cantilever for various types of loading, deflection of simply supported beam for various types of loading. Conjugate beam method.

Module 2:Torsion: (9 Hrs.)
Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts, torsional rigidity. Combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion.

Module 3: Thin Cylinders and Thick cylinders: (9 Hrs.)
Thin Cylinders and Spheres- Derivation of formulae and calculations of hoop stress, longitudinal stress in a cylinder, and sphere subjected to internal pressures. Thick cylinders – Lame's equation, shrink fit. Compound cylinders.

Module 4:Columns and Struts: (9 Hrs.)
Introduction, failure of a column , basic assumptions, different end conditions, expression for crippling for different end conditions Effective length of a column. Slenderness ratio, Limitations of Euler's formula, Rankine's formula, factor of safety.

References/ Suggested Learning Resources:-

1. Pytel A H and Singer F L, Strength of Materials, Harper Collins.
2. Dr. R K Bansal, Strength of Materials, Laxmi Publications (P) Ltd.
3. Timoshenko S P and Young D H, Elements of Strength of Materials, East West Press.
4. Beer P F and Johston (Jr) E R, Mechanics of Materials: SI Version, McGraw Hill.
5. Shames, I. H., Pitarresi, J. M., Introduction to Solid Mechanics, Prentice-Hall.
6. Khurmi, R.S., Strength of Materials, S.Chand and Co, Revised edition.
7. NPTEL courses, http://nptel.iitm.ac.in/courses.php, web and video courses on Strength of Materials by Prof. Sharma, S. C., and Prof. Harsha, S. P.
8. Nash W., Strength of Materials Schaum's out line series, Mc Graw Hill.
9. Subramanian, R., Strength of Materials, Oxford University Press, New Delhi.
10. Punmia, Mechanics of Materials, Laxmi Publications.

Manufacturing Process - I

Course Code	**PC ME 406**
Course Title	**Manufacturing Process - I**
Number of Credits	**3 (L: 3, T: 0, P: 0)**
Prerequisites	**Nil**
Course Category	**Program Core (PC)**
Number of classes	**36 hours**

Course Outcome:

	At the end of the course, the student will be able to:	
CO1	Explain the fundamentals of primary shaping processes	K2
CO2	Calculate the cutting forces during material removal processes.	K3
CO3	Design differentwelding joints.	K4
CO4	Calculate material removal rate(MRR) during unconventional machining	K3

Course Content:

Module 1: Conventional Manufacturing processes:(09 hours)

Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification,shrinkage, riser design, casting defects and residual stresses.Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; **Mechanical Working of Metals**:fundamentals ofhot and cold working processes; load estimation for bulk forming(forging, rolling, extrusion,drawing) and sheet forming (shearing, deep drawing, bending)principles of powder metallurgy.

Module 2:Machining Processes:(09 hours)

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chipformation, Tool wear and tool life, Surface finish and integrity, Machinability, cutting tool materials,Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNCmachining. **(8)**

Module 3: Joining and Fabrication Processes:(07 hours)

Additive manufacturing: Rapid prototyping and rapid tooling**.Joining/fastening processes:** Physics of welding, brazing and soldering;design considerations inwelding,Solid and liquid state joining processes;Adhesive bonding.

Module 4:Unconventional Machining Processes:(11 hours)

Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, UltrasonicMachining, principles and process parameters. Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear,dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant&maskant, process parameters, MRR and surface finish.Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining.

References / Suggested Learning Resources:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-PearsonIndia, 2014
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems

3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing.
4. Manufacturing Technology by P.N. Rao., McGraw HILL INDIA.
5. Materials and Manufacturing by Paul Degarmo.
6. Manufacturing Processes by Kaushish, PHI.
7. Principles of Foundry Technology, Jain, MCGRAW HILL INDIA.
8. Production Technology by RK Jain.

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Strength of Materials Lab

Course Code	PC ME 407
Course Title	Strength of Materials Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	---
Course Category	ProgramCore (PC)
Number of classes	24 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Perform Tension, shear and torsion test on solid materials	K3
CO-2	Determine the Toughness of the material using CHARPY and IZOD Test.	K4
CO-3	Determine the Brinnell and Rockwell hardness number of the given specimen.	K4
CO-4	Estimate the elastic constants through compression test on springs and deflection test on beams	K4

List of Experiments *(Minimum 6 experiments to be performed).*

Sl. No.	Practical Exercises
1.	To study the Brinell Hardness testing machine and the Brinell hardness test.
2.	2. To study the Rockwell Hardness testing machine and perform the Rockwell hardness test.
3.	3. To study the Vickers Hardness testing machine and perform the Vickers hardness test.
4.	4. To study the Impact Testing machine and Perform Izod impact test.
5.	To study the Impact Testing machine and Perform charpy impact test.
6.	To study the UTM and perform the tensile test.
7.	To Perform compression test on UTM.
8.	To perform the bending test on UTM.
9.	To perform the shear (both single and double) test on UTM.
10.	Torsion test on mild steel rod.

References/ Suggested Learning Resources:-

1. Khurmi, R S, Strength of Materials, S. Chand and Co.

2. Hatt , W.K., Laboratory Manual of Testing Materials.

3. Dr. R K Bansal, Strength of Materials, Laxmi Publications (P) Ltd.

4.Timoshenko S P and Young D H, Elements of Strength of Materials, East West Press.

5.Beer P F and Johston (Jr) E R, Mechanics of Materials: SI Version, McGraw Hill.

6.Shames, I. H., Pitarresi, J. M., Introduction to Solid Mechanics, Prentice-Hall.

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Fluid Mechanics Lab

Course Code	PC ME-408
Course Title	Fluid Mechanics Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Fluid Mechanics – I & II
Course Category	Program Core (PC)
Number of classes	20 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Explain the collected data for Venturimeter.	K2
CO-2	Calculate the collected data with the small orifice/mouthpiece and Orifice meter.	K3
CO-3	Find out various losses during flow through pipes.	K3
CO-4	Analyze the data related to the experiment with Bernoulli's apparatus.	K4

Course Content:

List of experiments:*(Minimum 6 experiments to be performed)*

1. Calibration of Venturimeter
2. Calibration of Orificemeter.
3. Calibration of Rotameter.
4. Determining the Coefficient of discharge for small orifice by constant head method.
5. Determining the Coefficient of discharge for mouthpiece by constant head method.
6. Calibration of contracted Rectangular Notch.
7. Calibration of Triangular Notch.
8. Determination of friction factor of a pipe.
9. Determination of Coefficient for minor losses.
10. Verification of Bernoulli's equation.

References / Suggested Learning Resources:

1. Desmukh, T S, Fluid Mechanics and Hydraulic Machines A Lab Manual.
2. Lab manuals available in the laboratory.

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Manufacturing Lab

Course Code	PC ME 409
Course Title	Manufacturing Lab

Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Manufacturing Process
Course Category	Program Core 9 (PC)
Number of classes	24 hours

Course Outcome:

After completion of the course, students will be ableto :

	CO Description	K-level
CO1	To know Metal Forming operation with various equipments	K3
CO2	To perform Hydroforming operation.	K4
CO3	To perform Ring compression test	K4
CO4	To study Forging defects.	K4

List of Experiments *(Minimum 6 experiments to be performed)*

Sl. No.	Practical Exercises
1.	Familiarization with Metal Forming operation and Equipments
2.	To perform upsetting operation.
3.	To perform Extrusion operation
4.	To perform Multi step forging operation.
5.	To perform Hammer Forging operation
6.	To perform Rolling operation.
7.	To perform Sheet metal working operation.
8.	To perform Orbital Forming operation.
9.	To perform Hydroforming operation.
10.	To perform Stretch forming operation
11.	To perform Cogging operation
12.	To perform Swaging operation.
13.	To perform Stamping operation.
14.	To perform Quenching operation.
15.	To perform Riveting operation.
16.	To perform Ring compression test
17.	To study Forging defects.

References/ Suggested Learning Resources:-

1. http://msvs-dei.vlabs.ac.in/msvs-dei/Metal_Forming.php
2. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of WorkshopTechnology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
3. Kalpakjian S. and Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
4. Gowri P. Hariharan and A. Suresh Babu, "Manufacturing Technology – I" Pearson Education, 2008.
5. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India,1998.
6. Rao P.N., "Manufacturing Technology"

Essence of Indian Knowledge Tradition

Course Code	MC-410

Course Title	Essence of Indian Knowledge Tradition
Number of Credits	0 (L: 2, T: 0, P: 0)
Prerequisites	Nil
Course Category	Mandatory Course (MC)
Number of classes	26 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Outline Vedic literature, Puranic Literature and other ancient knowledge tradition of India.	K-2
CO-2	Explain about scientific heritage of ancient India along with comprehending its relevance and application in various modern scientific disciplines.	K-2
CO-3	Demonstrate Indian Philosophical systems with a conscious emphasis on their relevance and application in modern scientific enquiry.	K-2
CO-4	Illustrate Indian Linguistic tradition along with its branches.	K-2
CO-5	Critically analyse the worth of Indian intellectual heritage, traditional practices and Indian lifestyle from scientific lenses.	K-4

Course Content:

Module 1: Introduction to Vedic Literature, Dharmaśāstra and Purāṇas (08 hrs)

- General structure of Vedic Literature,
- Different theories on the age of the Vedas,
- Educational system in the Vedic times
- Subject-matter of Ṛgveda-samhitā, *Sāmaveda -Saṁhitā, Yajurveda-Saṁhitā, Atharvaveda-Saṁhitā, Brāhmaṇa* and *Āraṇyaka* literature, Upaveda
- Vedāṅga Literature
- History of Dharmaśāstra
- Basic concepts of *Purāna*s

Module 2: Indian Knowledge System, Yoga and Health care (06 hrs)

- Origin and Development of Indian Knowledge System
- Concept of Dharma in Indian knowledge tradition
- General ideas about Yoga,
- Origin and Development of Pātañjala Yoga
- Origin and Development of Āyurveda and its relevance

Module 3: Introduction to Indian Philosophy (06 hrs)

- General introduction to Indian Philosophical systems, i.e. Orthodox and Heterodox
- Concept of *Puruṣārtha*s in Indian Philosophy
- General introduction of Upaniṣadic literature
- Indian Philosophy and Modern Science

- Principles in different philosophical systems
- Relevance of Indian Philosophy in Modern time

Module 4: Indian Linguistic and Artistic Tradition (06 hrs)

- Origin and Definition of Language
- Branches and aspects of Science of language
- Vedic and Classical Sanskrit
- Indo-European family of Language
- Role of Sanskrit in comparative Philology
- Sanskrit Phonology and Phonetic laws
- History of Sanskrit Grammar
- Introduction to Śikṣā literature
- Origin and Development of Artistic tradition

References / Suggested Learning Resources:

1) Capra, Fritjof. *The Tao of Phisics*. New York: Harpercollins, 2007.
2) Capra, Fritjof. *The Web of Life*. London: Harpar Collins Publishers, 1996.
3) Chaitanya, Krishna. *Arts of India*, Abhinav Publications, 1987.
4) Chatterjee, S.C & Datta, D.M. *An Introduction to Indian Philosophy*, Calcutta: University of Calcutta, 1984.
5) Cowell, E.B and Gough. A.E (Ed.), *Sarvadarśanasaṅgraha*. Sadguru Publications, 2008.
6) Dasgupta, Surendranath & De, Sushil Kumar. *A History of Sanskrit Literature.*Delhi: Motilal Banarsidass, 2017.
7) Dasgupta, Surendranath. *A History of Indian Philosophy*. Delhi: Motilal Banarsidass, 1991.
8) GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016.
9) Gonda, Jan. *A History of Vedic Literature*. Delhi: Monohar Publishers and Distributors, 2020.
10) Jha, R.N. *Science and Consciousness Psychotherapy and Yoga Practices*. Delhi: Vidyanidhi Prakashan, 2016.
11) Jha, V.N. Language, *Thought and Reality*.
12) Kane. P.V. *History of Dharmasastra*, Poona: Bhandarkar Oriental Research Institute, 1930.
13) Knowledge traditions and practices of India, CBSE Publications.
14) Max Muller. *Ancient Sanskrit Literature*, London: Spottiswoode and Co., 1859.
15) Nagaswamy, R. *Foundations of Indian Art*, Tamil Arts Academy, 2002.
16) Pride of India,New Delhi: Samskrita Bharati, 2006.
17) Shastri, Gourinath. *A History of Vedic Literature*, Kolkata: Sanskrit Pustak Bhandar, 2006.
18) Sinha, Jadunath. *Indian Philosophy*. Delhi: Motilal Banarsidass,1938.
19) Subrahmanialyer,K.S. *Vakyapadia of Bhrarthrihari*. Pune: Deccan College, 1965.
20) V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*. Mumbai: Bharatiya Vidya Bhavan, 5th Edition, 2014.
21) Wujastiyk, Dominik. *The Roots of Ayurveda*. India: Penguin India, 2000.

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Tripura University
(A Central University)

Curriculum

For

B. Tech in Mechanical Engineering

(5thSemester)

2021

5th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Total Marks
1.	Humanities Science -5	HU 501	Professional Practice, Law and Ethics	2	0	0	2	2	100
2.	Program Core-13	PC ME 502	Heat Transfer	3	0	0	3	3	100
3.	Program Core-14	PC ME 503	Non Conventional Energy Sources	3	0	0	3	3	100
4.	Program Core-15	PC ME 504	Design of Machine Elements	3	0	0	3	3	100
5.	Program Core-16	PC ME 505	Manufacturing Process - II	3	0	0	3	3	100
6.	Program Core-17	PC ME 506	Kinematics and Theory of Machines	3	0	0	3	3	100
7.	Program Core-18	PC ME 507	Heat Transfer Lab	0	0	2	2	1	100
8.	Program Core-19	PC ME 508	Machine Design Sessional	0	0	2	2	1	100
9.	Program Core-20	PC ME 509	Manufacturing Technology Lab	0	0	4	4	2	100
10.	Summer Internship-1	SI ME 510	Industry Internship - I	0	0	0	0	1	100
			Total :	17	0	8	25	**22**	**1000**

Professional Practice, Law and Ethics

Course Code	HU 501
Course Title	Professional Practice, Law & Ethics
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Nil
Course Category	Humanities Science (HS)
Number of classes	26 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K Level
CO 1	Develop ideas of the professionalism, values and ethics in a profession	K-3
CO 2	Develop a good insight into contracts and contracts management in engineering, arbitration and dispute resolution mechanisms	K-3
CO 3	Interpret laws governing engagement of labour in construction related works and other related areas	K-2
CO 4	Demonstrate an understanding of Intellectual Property Rights and Patents	K-2

Module1: Professionalism, Values and Ethics in Profession (6 hrs)

Professionalism: Professional characteristics, professional education, professional development in Industry.
Values and Ethics in Profession- Value system- goodness, means and ends; Ethics-ethical premises, expectation, conflicts and practices; Moral and ego, Ethics and morality
Right, virtue ethics and justice, utility and justice, privacy, challenges to privacy, privacy on the Internet.

ProfessionalEthics–DefinitionofEthics,ProfessionalEthics,BusinessEthics, CorporateEthics,EngineeringEthics,PersonalEthics;CodeofEthicsasdefinedinthewebsiteof InstitutionofEngineers(India);Profession,Professionalism,ProfessionalResponsibility, ProfessionalEthics;ConflictofInterest,GiftVsBribery,Environmentalbreaches,Negligence, Deficienciesin state-of-the-art;VigilMechanism,Whistleblowing,protecteddisclosures.

Module2: General Principles of Contracts Management and Arbitration (10 hrs)

IndianContractAct,1972andamendmentscoveringGeneralprinciplesofcontracting;Valid&VoidableContracts; Prime and Subcontracts Tenders, Request For Proposals,Bids&Proposals;BidEvaluation;Costescalation;Delays,Suspensions&Terminations;Timeextensions&ForceMajeure;DelayAnalysis;Liquidateddamages&Penalties;Insurance&Taxation.

Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system*:* Arbitration–meaning,scopeandtypes–distinctionbetweenlawsof1940and1996;Arbitrationagreements–essentialandkinds,validity,referenceandinterimmeasuresby court;Arbitrationtribunal–appointment,challenge,jurisdictionofarbitraltribunal,powers,grounds ofchallenge,procedureandcourtassistance;AwardincludingFormandcontent,Groundsforsetting asideanaward, Enforcement, Appeal and Revision.

Module3:EngagementofLabour&otherconstruction-relatedLaws (5 hrs)

Role of Labour inCivilEngineering;Methodsofengaginglabour-onrolls,laboursub-contract,pieceratework; IndustrialDisputesAct,1947;Collectivebargaining;IndustrialEmployment(StandingOrders)Act, 1946;Workmen'sCompensationAct,1923;Building&OtherConstructionWorkers(regulationof employment and conditions of service)Act(1996) and Rules (1998);RERAAct2017, NBC 2017.

Module4:LawrelatingtoIntellectualproperty (5 hrs)

Introduction–meaning of intellectual property, main forms ofIP,Copyright,Trademarks,PatentsandDesigns,Secrets;CopyRightsAct,1957,Meaningofcopyright–computer programs,Ownershipofcopyrightsandassignment,Criteriaofinfringement,PiracyinInternet–RemediesandproceduresinIndia;LawrelatingtoPatentsunderPatentsAct,1970including Conceptandhistoricalperspectiveofpatentslawin India.Processofobtaining patent–application,examination,oppositionandsealingofpatents.Durationofpatents–lawandpolicy considerations, Infringement and related remedies;

References / Suggested Learning Resources:

1. B.S. Patil,Legal Aspectsof BuildingandEngineeringContracts, 1974.
2.TheNationalBuildingCode,BIS,2017
3.MeenaRao(2006), Fundamental conceptsinLawof Contract, 3rdEdn.ProfessionalOffset
1 . NeelimaChandiramani(2000),TheLawofContract:AnOutline,2ndEdn.AvinashPublications Mumbai
5.Avtarsingh(2002),Lawof Contract, EasternBookCo. 7.Dutt(1994), IndianContractAct,Eastern LawHouse
6.T. Ramappa(2010),Intellectual PropertyRightsLawinIndia,AsiaLawHouse
9.Baretext(2005),RighttoInformationAct
7.O.P.Malhotra,Lawof Industrial Disputes,N.M. TripathiPublishers
8.Ethics inEngineering- M.W.Martin&R.Schinzinger, McGraw-Hill
9.EngineeringEthics,National InstituteforEngineeringEthics,USA.
1. Ethics & Mgmt and Ethos , Ghosh, VIKASH
2. Business Ethics; Concept and Cases, Velasqez, Pearson

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Heat Transfer

Course Code	PC ME 502
Course Title	Heat Transfer
Number of Credits	3 (L: 3, T:0, P: 0)
Prerequisites	Thermodynamics
Course Category	Program Core (PC)
Number of classes	36 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Distinguish the phenomena of steady and unsteady conduction.	K2
CO-2	Comprehendthe concepts of convection.	K3
CO-3	Analyze thermal radiation.	K4
CO-4	Evaluate the functionsof heat exchangers and illustrate Boiling.	K5

Course Content:

Module 1: Heat Conduction:(10 hours)

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Module 2: Heat Convection:(8 hours)

Heat convection,basic equations, boundary layers- Forced convection, external and internal flowsNatural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Module 3: Radiation Heat Transfer: (8 hours)

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.

Module 4: Heat Exchangers and Boiling: (10 hours)

Types of heat exchangers, Analysis and design of heat exchangers using bothLMTD and ε-NTU methods. Boiling and Condensation heat transfer, Pool boiling curve. Introduction mass transfer, Similarity between heat and mass transfer.

References / Suggested Learning Resources:

1. A. Bejan, Heat Transfer John Wiley, 1993.
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002 5. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002.

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Non Conventional Energy Sources

Course Code	PC ME 503
Course Title	Non Conventional Energy Sources
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	NIL
Course Category	Program Core (PC)
Number of classes	38 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Discussthe prospects of renewable energy sources and Describe the use of solar energy withrespect to applications like-heating, cooling, power generation, drying, etc.	K1
CO-2	Apply the principles of biomass conversion technologies and wind energy to solve practical problems.	K3
CO-3	Explain the concept of geothermal energy &ocean energy.	K2
CO-4	Summarize the operation of fuel cell and utilization of hydrogenas alternative fuel.	K2

Course Content:

Module 1: Introduction & Solar Energy: (10 hours)

Renewable and non-renewable energy sources, trends in energy consumption, Global and National scenarios, Prospects of renewable energy sources, Energy Management.

Solar Energy: Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, measurement of solar radiation, flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, Storage of solar energy-thermal storage, Photo voltaics – solar cells & its applications.

Module 2: Energy from Biomass&Wind Energy: (12 hours)

Calorific value of Biomass samples, Pyrolysis, Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design

consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.
Basic system principles, Assessment of wind available, Design principles, Manufactured designs, Sizing and storage of energy, System efficiency, Overview of wind industry.

Module 3: Geothermal Energy & Ocean Energy: (10 hours)
Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages, and application of geothermal energy.
Ocean Thermal Electric Conversion systems like open cycle, closed cycle, Hybrid cycle. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

Module 4: Fuel Cells & Hydrogen Energy: (6 hours)
Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, applications of fuel cells.
Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.

References / Suggested Learning Resources:

1. G.D. Rai, 2010, *Non-conventional energy sources*, Khanna Publishers.

2. Saeed and Sharma, 2013, *Non Conventional Energy Resources*, S.K. Kataria& Sons

3. S P Sukhatme, *Solar Energy-Principles of Thermal Collection & Storage*, Tata McGraw Hill Publishing Company Ltd.

4. Jay Cheng, 2009, *Biomass to Renewable Energy Processes*, CRC press

5. B H Khan, *Non-Convention Energy Resources,* McGraw Hill Education (India) Pvt. Ltd.

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Design of Machine Elements

Course Code	PCME 504
Course Title	Design of Machine Elements
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Strength of Materials
Course Category	ProgramCore (PC)
Number of classes	36 hours

Course Outcome:-
After completion of the course, students will be able to:

CO No	CO Description	K-level
CO-1	Analyze the influence of steady and variable stresses in machine component.	K4

CO-2	Apply the concepts of design to temporary and permanent joints.	K3
CO-3	Design the power transmission elements like shafts, keys and couplings	K5
CO-4	Design different types of Clutches and Brakes.	K5

Course Content:-

Module 1*:* Fundamentals of Design:(9hours)
Introduction to the design process,Factors influencing machine designLimits, fits and standardization, preferred numbers,Simple stresses, Stress strain relationship, Factor of safety, Direct, Bending and torsional stress equations, Theories of failures, Stress Concentration, Design for static loading, Design for variable loading.

Module 2:Temporary and Permanent Joints (9hours)
Design of Bolted joints including eccentric loading, Design of Welded joints, riveted joints,Knuckle joints, Cotter joints.

Module 3:Design of Shaft, Keys and Couplings: (9hours)
Design of solid and hollow shafts based on strength and rigidity. Design of Keys,Shaft Coupling, Requirements of a Good Shaft Coupling, Types of Shafts Couplings, Design of flangeand muffcouplings.

Module 4:Design of Clutches and Brakes**: (9hours)**
Design of Clutches: Necessity of a clutch in an automobile, types of clutches, friction materials and its properties. Design of single plate, multi-plate and cone clutches based on uniform pressure and uniform wear theories.
Design of Brakes: Different types of brakes, Concept of self-energizing and self-locking of brakes. Design of band brakes, block brakes and internal expanding brakes.

References/ Suggested Learning Resources: -

1. Shigley, J.E., Mechanical Engineering Design, 5th ed., McGraw-Hill,
2. Bhandari, V.B., ―Design of Machine element‖ Tata McGraw-Hill
3. Bhandari, V.B., ―Introduction to Machine Design‖ Tata McGraw-Hill
4. Khurmi, R.S., Gupta, J.K., ― A Text book of Machine Design‖ S. Chand Publication.
5. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan,
6. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley,
7. Spottes, M.F., Design of Machine elements, Prentice-Hall India,
8. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall.

Manufacturing Process - II

Course Code	**PC ME 505**
Course Title	Manufacturing Process - II
Number of Credits	**3 (L: 3, T: 0, P: 0)**
Prerequisites	**Nil**
Course Category	Program Core (PC)
Number of classes	**36 hours**

Course Outcome:

	At the end of the course, the student will be able to:	
CO1	Select proper tools, jigs and fixture for machining operation.	K3

CO2	Use of different heat treatment methods.	K3
CO3	Design different types of plastics and composite fabrication methods.	K4
CO4	Choose various Flexible Manufacturing Systems.	K4

Course Content:

Module 1: Tools, Jig and Fixture for Machining Processes.: (07 hours)

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design.

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Module 2:Metallurgy of Iron: (10 hours)

Terms Involved in Metallurgy, Important Ores of Iron, Extraction, Smelting in Blast Furnace, Chemical Reactions in Blast Furnace, Products of Blast Furnace, their Composition, and application. Commercial Forms of Iron - Pig Iron / Cast Iron, Wrought or Malleable Steel, their composition, types, properties & applications. Constitution of alloys, Iron – Iron carbide equilibrium diagram. Classification of steel and cast Iron: their microstructures, properties, and applications. Heat Treatments.

Module 3: Processing of Plastics and Composites: (10 hours)

Types of plastics – Processing of thermo plastics – Extrusion, Inspection blow, Rotatromalmoulding processes – Calendaring, Film blowing, Thermo forming Processing of thermosets - Compression, Transfer, Jet Moulding processes – Bonding of thermoplastics- Laminated plastic — Composites- types- Fabrication Methods advantages, limitations, and applications.Overview of Powder Metallurgy technique - Advantages - applications - Powder preform forging -powder rolling - Tooling and process parameters.

Module 4:Flexible Manufacturing Systems(FMS): (09 hours)

Introduction to FMS– development of manufacturing systems – benefits – majorelements – types of flexibility – FMS application and flexibility –single product, singlebatch, n – batch scheduling problem – knowledge-based scheduling system.Computer Control and software for Flexible Manufacturing Systems, Applications of FMS,and factory of the future.

References / Suggested Learning Resources:

1.Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014.
2.Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd.,
3. Donaldson, Lecain and Goold “Tool Design”, III rd Edition Tata McGraw Hill, 2000.
4. G.S. Upadhyay and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt. Ltd., New Delhi.
5. Kenneth G. Budinski and Michael K. Budinski, “Engineering Materials”, PHI.
6. Sydney H.Avner, “Introduction to Physical Metallurgy”, McGraw Hill Book Company.
7. Raouf, A. and Ben-Daya, M., Editors, “Flexible manufacturing systems: recent development”, Elsevier Science, 1995.

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Kinematics and Theory of Machine

Course Code	PC ME 506
Course Title	Kinematics and Theory of Machine
Number of Credits	3 (L: 3, T: 0, P: 0)

Prerequisites	---
Course Category	Program Core (PC)
Number of classes	36 hours

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

CO No	CO Description	K-level
CO-1	Demonstrate the mechanisms, their motion and the inversions of four bar mechanisms.	K2
CO-2	Analyzing the velocity, acceleration at any point in a link and joints of mechanisms.	K4
CO-3	Analysis of cam follower motion for the motion specifications and friction in machine elements.	K4
CO-4	Explain the concepts of toothed gearing and kinematics of gear trains and the effects of motion transmission in machine components.	K3

Course Content:-

Module 1: Basics of Mechanisms (9 hours)
Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Dwell mechanisms, Ratchets and Escapements, Universal Joint.

Module 2: Kinematics of Linkage Mechanisms (9 hours)
Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method – Velocity and acceleration polygons – Velocity analysis using instantaneous centers – Kinematic analysis by complex algebra methods – Vector approach – Coincident points – Coriolis component of Acceleration – Introduction to linkage synthesis problem.

Module 3: Kinematics of Cam Mechanisms (9 hours)
Classification of cams and followers – Terminology and definitions – Displacement diagrams – Uniform velocity, parabolic, simple harmonic, cycloidal and polynomial motions – Derivatives of follower motions – Pressure angle and undercutting – sizing of cams.
Friction in Machine Elements: Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction aspects in brakes.

Module 4: Gears and Gear Trains (9 hours)
Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions – Gear tooth action – contact ratio – Interference and undercutting – Non-standard gear teeth – Helical, Bevel, Worm, Rack and Pinion gears [Basics only] – Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains – Differentials.

Text / References Book:

1. Dr. R K Bansal, Strength of Materials, Laxmi Publications (P) Ltd.
2. Rattan, S.S, "Theory of Machines", 3rd Edition, Tata McGraw-Hill.
3. Thomas Bevan, 'Theory of Machines', 3rd Edition, CBS Publishers and Distributors.
4. Cleghorn, W. L, "Mechanisms of Machines", Oxford University Press.
5. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill.
6. Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall.

7. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines', Affiliated East-West Pvt. Ltd., New Delhi.
8. Rao.J.S. and Dukkipati.R.V. 'Mechanisms and Machine Theory', Wiley-Eastern Ltd., New Delhi.
9. John Hannah and Stephens R.C., 'Mechanics of Machines', Viva Low-Prices Edition.
10. V.Ramamurthi, Mechanics of Machines, Narosa Publishing House.
11. Khurmi, R.S.,"Theory of Machines",14th Edition, S Chand Publications
12. Shigley, J.E and Uicker, J.J: Theory of Machines and Mechanisms, Oxford University Press
13. Green, W.G: Theory of Machines, 2nd Edition, Blackie, London, 1992.
14. Hollowenko, A.R: Dynamics of Machinery, John wiley and sons. Inc. New York, 1955.
15. Wilson, Kinematics and Dynamics of Machinery, 3rd Edition, Pearson Education.

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Heat Transfer Lab

Course Code	PC ME-507
Course Title	Heat Transfer Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Heat Transfer and Thermodynamics
Course Category	Program Core (PC)
Number of classes	20 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Explain the thermal conductivity of compositewall and other systems.	K2
CO-2	Calculate the collected data for heat transfer coefficient underconvections.	K3
CO-3	Determine the emissivity and Stefan-Boltzmann Constant of amass.	K3
CO-4	Analyze the effectiveness of heatexchanger.	K4

Course Content:

List of experiments:*(Minimum 6 experiments to be performed)*

1. Thermal conductivity measurement using guarded plateapparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipeapparatus.
3. Determination of heat transfer coefficient under natural convection from a verticalcylinder.
4. Determination of heat transfer coefficient under forced convection from atube.

5. Determination of Thermal conductivity of compositewall.
6. Determination of Thermal conductivity of insulatingpowder.
7. Heat transfer from pin-fin apparatus (natural & forced convectionmodes)
8. Determination of Stefan – Boltzmannconstant.
9. Determination of emissivity of a greysurface.
10. Effectiveness of Parallel / counter flow heatexchanger.

References / Suggested Learning Resources:

1. https://www.bitswgl.ac.in/lab-manuals-mech/4.Ht%20lab_mannual.PDF.
2. Lab manuals available in the laboratory.

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Machine Design Sessional

Course Code	PC ME 508
Course Title	Machine Design Sessional
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Design of Machine Elements
Course Category	Program Core (PC)
Number of classes	20 hours

Course Outcome:-
After completion of the course, students will be able to:

CO No	CO Description	K-level
CO-1	Design different types of temporary and permanent joints.	K5
CO-2	Apply the concepts of design totransmission elements like shafts.	K3
CO-3	Design different types of coupling.	K5
CO-4	Design different types of Clutches and Brakes.	K5

List of Experiments*(Minimum 6 experiments to be performed).*

1. To design and draw a knuckle joint.
2. To design and draw a cotter joint.
3. To design and draw a riveted joint
4. To design and draw a welded joint.
5. To design and draw a shaft subjected to torsion, bending moment and combined torsion and bending.
6. To design and draw a flange coupling.
7. To design and draw a muff coupling.
8. To design and draw a disc clutch based on uniform pressure and uniform wear theories

9. To design and draw ablock brake.

10. To design and draw an internal expanding brake

References / Suggested Learning Resources: -

9. 1. Shigley, J.E., Mechanical Engineering Design, 5th ed., McGraw-Hill,
10. Bhandari, V.B., ―Design of Machine element‖ Tata McGraw-Hill
11. Bhandari, V.B., ―Introduction to Machine Design‖ Tata McGraw-Hill
12. *Khurmi, R.S., Gupta, J.K., ― A Text book of Machine Design‖ S. Chand Publication.*
13. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan,
14. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley,
15. Spottes, M.F., Design of Machine elements, Prentice-Hall India,
16. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall,

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Manufacturing Technology Lab

Course Code	PC ME 509
Course Title	Manufacturing Technology Lab
Number of Credits	2 (L: 0, T: 0, P: 4)
Prerequisites	Manufacturing Technology
Course Category	Program Core (PC)
Number of classes	40 hours

Course Outcome:

After completion of the course, students will be able :

	CO Description	K-level
CO1	To do CNC Turning operation	**K3**
CO2	To perform Electric Discharge Machining operation	**K4**
CO3	To perform Fiber laser cutting of stainless-steel sheet	**K4**
CO4	To perform Gear manufacturing operation.	**K4**

List of Experiments *(Minimum 10 experiments to be performed).*

Sl. No.	Practical Exercises
1.	To perform CNC Turning operation
2.	To perform Computer Controlled Cutting of wooden object
3.	To perform 3D Machining
4.	To perform PCB design & fabrication
5.	To perform Interface & Application Programming
6.	To perform Digital Fabrication of Flexible Circuit board
7.	To perform 3D scanning.
8.	To perform Molding and Casting of Polyurethane parts
9.	To perform Digital Fabrication and Project Development
10.	To perform Electric Discharge Machining operation
11	To perform Fiber laser cutting of stainless-steel sheet

12	To perform Crankshaft Forming operation.
13	To perform Connecting Rod forming operation
14	To perform Screw head manufacturing operation.
15	To perform Gear manufacturing operation.
16	To perform Bar shearing operation.
17	To perform Medical implants operations
18	To perform Ripple process

References/ Suggested Learning Resources: -

1. *http://msvs-dei.vlabs.ac.in/msvs-dei/Metal_Forming.php*
2. *http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAM/index.html*
3. *http://fab-coep.vlabs.ac.in/Introduction.html*
4. *http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpMM/index.html*
5. *http://mrmsmtbs-iitk.vlabs.ac.in/home*
6. 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
7. Kalpakjian S. and Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
8. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
9. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India,1998. 5. Rao P.N., "Manufacturing Technology"

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Industry Internship– I

Course Code	SI ME 510
Course Title	Industry Internship – I
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Summer Internship (SI)
Number of classes	-

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Solve real life challenges in the workplace by analysing work environment and conditions, and selecting appropriate skill sets acquired from the course of study	K-3
CO-2	Develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting	K-3
CO-3	Demonstrate the skill to communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means	K-2
CO-4	Show professional ethics by displaying positive disposition during internship.	K-2

CO-5	Decide career options by considering opportunities in company, sector, industry, professional, educational advancement and entrepreneurship;	K-5

Course Content:-

The industry internship aims to provide the student with:

1. A practice-oriented and 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.

2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting.

3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real world work environment.

4. Pre-employment training opportunities and an opportunity for the company or organisation to assess the performance of the student and to offer the student an employment opportunity after his/her graduation, if it deems fit.

Each student shall

1) Identify an internship program of relevance in his/her branch of engineering to undergo during summer break between 4^{th} and 5^{th} semester,
2) Get approval of the concerned HOD,
3) Undergo the industry internship program for minimum 4 weeks duration
4) Prepare their own report
5) Present in the class among fellow students and faculty members / deliver viva voce.
6) Submit the report and participation/course completion certificate.

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Tripura University
(A Central University)

Curriculum

For

B. Tech in Mechanical Engineering

(6th Semester)

2021

6th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Total Marks
1.	Program Core-21	PC ME 601	Fluid Power Engineering	3	0	0	3	3	100
2.	Program Core-22	PC ME 602	Mechanical Vibration	3	0	0	3	3	100
3.	Program Core-23	PC ME 603	Dynamics of Machine	3	0	0	3	3	100
4.	Program Core-24	PC ME 604	Refrigeration and Air Conditioning	3	0	0	3	3	100

5.	Program Core-25	PC ME 605	Mechanical Vibration & Dynamics of Machine Lab	0	0	2	2	1	100
6.	Program Core-26	PC ME 606	Fluid Machines Lab	0	0	2	2	1	100
7.	Program Core-27	PC ME 607	Refrigeration and Air Conditioning Lab	0	0	2	2	1	100
8.	Program Elective-1	PE ME 608/1	1.Internal Combustion Engines	3	0	0	3	3	100
		PE ME 608/2	2. Mechatronics Systems	3	0	0			100
		PE ME 608/3	3. Computer Aided Design	3	0	0			100
9.	Project - 1	PR ME 609	Mini Project	0	0	6	6	3	100
			Total :	15	0	12	27	**21**	**900**

FLUID POWER ENGINEERING

Course Code	PC ME-601
Course Title	Fluid Power Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Fluid Mechanics – I & II and Mathematics
Course Category	Program Core (PC)
Number of classes	36 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Explain the fundamentals behind the amount of force exertedby the impact of jets on different plates.	K2
CO-2	Calculate the problems related to hydraulic turbines.	K3
CO-3	Analyze basic principles related to hydraulic pumps.	K4
CO-4	Evaluate basic problems related to model testing of turbines, pumps and other hydraulic systems.	K5

Course Content:

Module 1: Impact of jets: (06 hours)

Classification of fluid mechanics. Impact of free jets – force, work done, efficiency on stationary and moving flat plates, hinged flat plates, stationary and moving curved vanes, Jet propulsion of ships. Classification of hydraulic turbines and hydraulic pumps.

Module 2: Hydraulic turbines: (10 hours)

Work done, power and efficiencies of Pelton turbines, Francis turbines, Kaplan turbine and Propeller turbine. Working proportion and design of Pelton wheel and Francis turbine runner. Draft tube, Cavitation, Performance characteristic of hydraulic turbine, Governing of hydraulic turbine, Surge tanks, specific speed, selection of turbines.

Module 3: Centrifugal and reciprocating pumps: (10 hours)

Centrifugal Pump --- main components, work-done, heads and efficiencies. Losses in centrifugal Pump, minimum starting speed, multistage pumps, specific speed, net positive suction head, cavitation, priming, selection of pumps, performance characteristics, operational difficulties of Centrifugal Pump, design consideration.

Reciprocating Pump --- main components, discharge, work-done, power, slip indication diagram, effect of friction and acceleration in suction and delivery pipes on indicator diagrams. Air Vessels, Centrifugal and axial flow compressors. Fans and blowers.

Module 4: Miscellaneous hydraulic systems: (10 hours)

Model studies – objectives and importance. Similitude, distorted models, model relationships of turbines, scale effect, Model testing of centrifugal pumps.

Other hydraulic systems – hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic lift, hydraulic ram, hydraulic coupling and torque converter. Air lift pump and Jet pump.

References / Suggested Learning Resources:

1. Som, S. K., & Biswas, G. Introduction to fluid mechanics and fluid machines: Tata McGraw-Hill.
2. Bansal, R. K. A textbook of fluid mechanics and hydraulic machines, Laxmi Pub.
3. Rajput, R.K., A Textbook of Fluid Mechanics and Fluid Machines, S. Chand Pub.
4. Kumar, D.S., Fluid Mechanics and Fluid Power Engineering, S.K.Kataria& Sons.
6. NPTEL courses: http://nptel.iitm.ac.in/courses.php - web and video resources on Fluid Mechanics.

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Mechanical Vibrations

Course Code	PC ME 602
Course Title	Mechanical Vibrations
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Theory of Machines
Course Category	Program Core (PC)
Number of classes	36 hours

Course Outcome: -

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

CO No	CO Description	K-level
CO-1	Solve the equations of motion for single DOF systemsof free vibration.	K3
CO-2	Formulate the equations of motion for single DOF systems of forced vibration.	K5
CO-3	Calculate the natural frequencies and mode shapes oftwo DOF systems.	K3
CO-4	Apply appropriate strategies for Vibration control.	K3

Course Content:-

Module 1*:* Single Degree of Freedom Systems-Free Vibrations: (9 hours)

Introduction to vibration, definitions and basic concepts, degree of freedom, types of vibrations, Undamped free vibrations, spring mass system, equivalent stiffness of spring combinations, longitudinal vibrations, transverse vibrations, torsional vibrations;Damped free vibrations, types of damping, free vibrations with viscous damping, logarithmic decrement, dry friction or coulomb damping.

Module 2:Single Degree of Freedom Systems-Forced Vibrations: (9 hours)

Forced vibrations with constant harmonic excitation, magnification factor, vibrations with rotating & reciprocating unbalance, vibrations due to excitation of the support, vibrations with coulomb damping.

Module 3:Two Degree of Freedom Systems: (9 hours)

Introduction, principal modes of vibration, spring mass coupled systems, double pendulum, torsional systems, systems with damping. Critical speed of a light shaft.

Module 4:Vibration Control: (9 hours)

Vibration isolation and transmissibility, force transmissibility, motion transmissibility, vibration absorbers, vibration measuring instruments, vibration control, vibration dampers and vibration isolators.

References/ Suggested Learning Resources: -

1. G. K. Grover," Mechanical Vibrations", Nemchand Publication, New Delhi
2. A. G. Ambekar, "Mechanical Vibrations and Noise Engineering, PHI, New Delhi
3. K.K. Purjara, Mechanical Vibrations, Dhanpat Rai and Sons, Delhi
4. V.P.Singh, Mechanical Vibrations Dhanpat Rai and Sons, Delhi
5. Debabrata Nag, Mechanical Vibration, John Wiley India
6. Thomson, Mechanical Vibration, Prentice Hall
7. Rao, S. S., "Mechanical Vibrations", 5th edition, Pearson Education
8. http://nptel.ac.in/courses/112103112/
9. http://nptel.ac.in/downloads/112104040

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Dynamics of Machines

Course Code	PC ME 603
Course Title	Dynamics of Machines
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Theory of Machines
Course Category	Program Core (PC)
Number of classes	36 hours

Course Outcome: -

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

CO No	CO Description	K-level
CO-1	Calculate static and dynamic forces of mechanisms.	K3

CO-2	Calculate the balancing masses and their locations of reciprocating and rotating masses.	K3
CO-3	Determine the speed and lift of the governor.	K6
CO-4	Estimate the Fluctuation of energy of the flywheel and the gyroscopic effect on body moves along a curved path.	K2

Course Content:-

Module 1*:* Force Analysis: (9 hours)
Force Analysis: Applied and constraint forces, Free body diagrams, Static equilibrium conditions, Static force analysis of simple mechanisms, Dynamic force analysis, Inertia force and Inertia torque, D Alembert's principle, Dynamic Analysis in reciprocating engines, Gas forces, Engine force analysis, Piston effort, Force along the connecting rod, Thrust on the sides of the cylinder, Crank effort, Thrust on the bearing, Turning moment on crank shaft.

Module 2:Balancing:(9 hours)
Balancing: Static and dynamic balancing,Balancing of rotating masses and reciprocating masses, Balancing a single cylinder engine, Balancing of Multi-cylinder inline, V-engines, Partial balancing in engines,Partial Balancing of Locomotives, Variation of Tractive Force, Swaying Couple, Hammer Blow.

Module 3:Governors: (9 hours)

Governors: Types, Porter, Proell, Hartnell, Centrifugal, Gravity controlled and spring controlled centrifugal governors & their characteristics, Effect of friction and inertia. Controlling force.

Module 4:Mechanism for Control: (9 hours)

Flywheel, Turning moment diagram for different types of engines, Fluctuation of energy and speed, Flywheel Rim dimension. Operation of flywheel in punching press. Gyroscopes, Gyroscopic forces and torques, Gyroscopic stabilization, Gyroscopic effects in Automobiles, ships and airplanes.

References/ Suggested Learning Resources: -

1. F. B. Sayyad, "Dynamics of Machinery", McMillan Publishers India Ltd., Tech-Max Educational resources, 2011.
2. Rattan, S.S, "Theory of Machines", 4th Edition, Tata McGraw-Hill, 2014.
3. Thomas Bevan, Theory of Machines, CBS Publishers and Distributors.
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill.
5. Ghosh. A and Mallick, A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd., New Delhi.
6. Rao.J.S. and Dukkipati.R.V. Mechanisms and Machine Theory, Wiley-Eastern Ltd., New Delhi.
7. V.Ramamurthi, Mechanics of Machines, Narosa Publishing House.
8. Khurmi, R.S., Theory of Machines, S Chand Publications

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Refrigeration and Air Conditioning

Course Code	PC ME 604

Course Title	Refrigeration and Air Conditioning
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Thermodynamics
Course Category	Program Core (PC)
Number of classes	38 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Apply principle of refrigeration for given system.	K3
CO-2	Select relevant refrigeration cycle for a given application.	K4
CO-3	Recommend refrigeration system components and refrigerants for given refrigeration system.	K5
CO-4	Calculate different air properties using psychrometric principle and different cooling load on given air conditioning system.	K3

Course Content:

Module 1: Introduction &Air refrigeration: (10 hours)

Definition andnecessity of refrigeration, refrigerating effect-unit of refrigeration-concept of COP, types of refrigeration-Ice, dry ice, Steam jet, throttling, liquid nitrogen refrigeration; thermodynamics of refrigeration, reversed Carnot cycle and its representation on P-V and T-S diagram, heat pump, limitations of reversed Carnot cycle, Bell - Coleman cycle, P-V & T-S diagram, air refrigeration system, component of air refrigeration system, its applications , advantage and disadvantages in air refrigeration.

Module 2: Vapour compression & Vapour absorptionrefrigeration systems: (10 hours)

Simple cycle, T- S and P- H diagrams, COP, effect of operating parameters on COP, methods of improving COP of simple cycle, super heating , under cooling, liquid suction heat exchanger, actual cycle, advanced vapour compression cycles, Ammonia –water system, simple system, drawbacks, lithium bromide water system, Electrolux refrigeration system , comparison with vapour compression system- steam jet refrigeration.

Module 3: Refrigeration System Components& Refrigerants: (08 hours)

Refrigeration Compressor-classifications, construction and working of hermitically sealed compressor, rotary compressors and applications, Condensers- classifications, working and applications, Evaporators-classifications, working and application., Expansion device- classifications, selection, working and application. Refrigerants and their properties, eco-friendly refrigerants, mixed refrigerants, selection of refrigerants for different applications, Ozone depletion and global warming issues.

Module 4: Basics of Air conditioning&Air conditioning systems: (10 hours)

Air conditioning- necessity, types of air conditioning, principle of psychrometry, psychrometric processes, representation of processes on psychrometric chart, comfort air conditioning and cooling load calculations, summer and winter air conditioning, year around air conditioning, central air conditioning, room air

conditioners, split air conditioning systems, concept of air handling unit, air distribution system, air washers, cooling towers, evaporative condensers, cooling and dehumidifying coils, insulation, introduction to automobile air conditioning system.

References / Suggested Learning Resources:

1. Gosney, W.B, *Principles of Refrigeration*, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., *Refrigeration and Air conditioning*, Tata McGraw Hill, 1986.
3. Arora, C.P., *Refrigeration and Air conditioning*, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., *Thermal Environmental Engineering*, 3rd Edition,Prentice Hall, 1998.
5. R J Dossat, *Principles of refrigeration,* John Wiley and sons Ltd.

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Mechanical Vibration and Dynamics of Machine Lab

Course Code	PCME 605
Course Title	Mechanical Vibration and Dynamics of Machine Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Mechanical Vibration, Dynamics of Machine
Course Category	Program Core (PC)
Number of classes	20 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Justify the relation of simple pendulum.	K6
CO-2	Determine the radius of gyration and frequency of different vibration system.	K3
CO-3	Experiment and draw the characteristics curves of different types of governors.	K3
CO-4	Demonstrate the effect of whirling of shaft and static and dynamic balancing system.	K3

List of Experiments*(Minimum 6experiments to be performed).*

1. To Verify the relation of simple pendulum.
2. To determine the radius of gyration K of a given compound pendulum.
3. To determine the radius of gyration K of given bar using bi-filer suspension.
4. To study the longitudinal vibration of helical spring and to determine the frequency of oscillation theoretically and actually by experiment.
5. To study the Watt Governor and draw the characteristics curve.
6. To study the Porter Governor and draw the characteristics curve.
7. To study the Proell Governor and draw the characteristics curve.

8. To study the Hartnell Governor and draw the characteristics curve.
9. To study the effect of whirling of shaft.
10. To study the static and dynamic balancing system

References/ Suggested Learning Resources: -

10. 1. G. K. Grover," Mechanical Vibrations", Nem chand Publication, New Delhi
11. A. G. Ambekar, "Mechanical Vibrations and Noise Engineering, PHI, New Delhi
12. K.K. Purjara, Mechanical Vibrations, Dhanpat Rai and Sons, Delhi
13. V.P.Singh, Mechanical Vibrations Dhanpat Rai and Sons, Delhi
14. Debabrata Nag, Mechanical Vibration, John Wiley India
15. F. B. Sayyad, "Dynamics of Machinery", McMillan Publishers India Ltd., Tech-Max Educational resources, 2011.
16. Rattan, S.S, "Theory of Machines", 4th Edition, Tata McGraw-Hill, 2014.
17. Rao.J.S. and Dukkipati.R.V. Mechanisms and Machine Theory, Wiley-Eastern Ltd., New Delhi.
18. V.Ramamurthi, Mechanics of Machines, Narosa Publishing House.
19. Khurmi, R.S., Theory of Machines, S Chand Publications

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Fluid Machines Lab

Course Code	PCME-606
Course Title	Fluid Machines Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Fluid Machines
Course Category	Program Core (PC)
Number of classes	20 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Explain the procedure forcollecting data to find out the hydraulic force of water jet on vanes.	K2
CO-2	Calculate the collected data to find out the efficiency of turbines.	K3
CO-3	Find out the overall efficiency of pump.	K3
CO-4	Analyze collected data to find out the efficiency of compressors.	K4

Course Content:

List of experiments:*(Minimum 6 experiments to be performed)*

1. Study the impact of jet on Vanes.
2. Study the Performance characteristics of Pelton Turbines.
3. Study the Performance characteristics of Francis Turbines.
4. Study the Performance characteristics of Kaplan Turbines.

5. Study the characteristics of centrifugal pumps.
6. Study the characteristics of reciprocating pumps.
7. Study the characteristics of two stage air compressors.
8. Study the characteristics Rotary air compressors.

References / Suggested Learning Resources:

1. Desmukh, T S, Fluid Mechanics and Hydraulic Machines A Lab Manual.
2. Lab manuals available in the laboratory.

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Refrigeration and Air Conditioning Lab

Course Code	PC ME 607
Course Title	Refrigeration and Air Conditioning Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Refrigeration and Air Conditioning
Course Category	Program Core (PC)
Number of classes	24 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Implement refrigeration cycles inrefrigeration system.	K3
CO-2	Evaluate performance of Vapour compression refrigeration system and Vapour absorption refrigeration system.	K5
CO-3	Analyze different psychrometric processes on general cycle air conditioning trainer.	K4
CO-4	Perform in split air-conditioner and window air-conditioner.	K3

Course Content:

List of experiments ***(Minimum6 experiments to be performed)***

1. Demonstration of Vapour compression refrigeration system and Vapour absorption refrigeration system.
2. Determination of the COP of Vapour compression refrigeration system.
3. Demonstration of the COP of Vapour absorption refrigeration system.
4. Study of domestic refrigerator and to determine % running time at different thermostat settings.
5. Study the working principle of steam jet refrigeration system.
6. Study of different psychrometric terms and processes
7. To understand construction and working of window air-conditioner/ split air-conditioner and to determine its capacity
8. Determine the COP, tonnage capacity and current consumption of an Ice plant
9. Design of Air Conditioning System and load calculation for residential and commercial buildings.

10. Study of measurement devices of all experimental setups used in RAC laboratory.

References / Suggested Learning Resources:

1. Gosney, W.B, *Principles of Refrigeration*, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., *Refrigeration and Air conditioning*, Tata McGraw Hill, 1986.
3. Arora, C.P., *Refrigeration and Air conditioning*, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., *Thermal Environmental Engineering*, 3rd Edition,Prentice Hall, 1998.
5. R J Dossat, *Principles of refrigeration,* John Wiley and sons Ltd.

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Internal Combustion Engines

Course Code	**PE ME 608/1**
Course Title	Internal Combustion Engines
Number of Credits	**3 (L: 3, T: 0, P: 0)**
Prerequisites	**Nil**
Course Category	Program Elective (PE)
Number of classes	**36 hours**

Course Outcome:

	At the end of the course, the student will be able to:	
CO1	Explain the fundamentals of IC Engine	K2
CO2	Illustrate different modes of fuel supply system in SI and CI engine.	K3
CO3	Practice use of appropriate grade of lubricating oil and coolant.	K3
CO4	Measure the vital engine parameter.	K4

Course Content:

Module 1: Basic Cycles and Combustion(10 hours)

Review of ideal cycles; Details of fuel-air cycles. Basic components and terminology of IC engines, working of four stroke/two stroke - petrol/diesel engine, classification and application of IC engines, engine. Combustion in SI and CIengines, Combustion stages, Combustion chambers and Abnormal combustion. **Supercharging**: Need for supercharging, Effect of supercharging, types of supercharger,

Module 2: Fuels supply and Ignition System(10 hours)

Important qualities of IC engine fuels, rating of fuels**,** Carburation, mixture requirement for different loads and speeds, simple carburetor and its working, types of carburetors, MPFI, types of injection systems in CI engine, fuel pumps and injectors, types of nozzles, spray formation.
Ignition System: Battery and magneto ignition system, spark plug, firing order,

Module 3: Engine Lubrication and Cooling: (08 hours)

Engine Lubrication and Cooling: Lubrication of engine components, Lubrication system – wet sump and dry sump, crankcase ventilation, Types of cooling systems – liquid and air cooled, comparison of liquid and air-cooled systems.

Module 4:Testing of IC Engine and Emission control: (08 hours)

Measurement of indicated power, brake power, fuel consumption and emission, Measurement of friction power.Air pollution due to IC engines, emission norms, HC, CO and NOx emission, catalytic convertor. Advanced IC Engine concepts.

References / Suggested Learning Resources:

1. Obert E. F, "Internal Combustion Engines and Air Pollution", Harper and Row Publication Inc. NY, 1973.
2. Heisler H, "Advanced Engine Technology", Edward Arnold, 1995.
3. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 1989
4. Heldt P. M, "High Speed Combustion Engines", Oxford & IBH publishing Co. India, 1985.
5. Stockel M W, Stockel T S and Johanson C, "Auto Fundamentals", The Goodheart, Wilcox Co. Inc., Illinois, 1996.

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Mechatronic Systems

Course Code	PE ME 608/2
Course Title	Mechatronic Systems
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	NIL
Course Category	Program Elective (PE)
Number of classes	36 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Select sensors and transducers to develop mechatronic systems.	K1
CO-2	Analyze automatic control and real time control systemswith the help of drives and actuators.	K4
CO-3	Explain the concept of smart materials.	K2
CO-4	Compare micromechatronic systemsthrough case studies.	K4

Course Content:

Module 1: Introduction & Sensors: (10 hours)

Definition of Mechanical Systems, Philosophy and approach; Systems and Design:Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface;
Sensors and transducers: classification, Development in Transducer technology, Opto-electronics- Shaft encoders, CD Sensors, Vision System, etc.

Module 2: Drives and Actuators: (10 hours)

Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor andStepper motor, 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;

Module 3: Smart Materials: (06 hours)
Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials,Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc

Module 4: Micromechatronic Systems: (10 hours)

Microsensors, Microactuators; 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.

References / Suggested Learning Resources:
1) Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company(Thomson Learning Inc.)
2) Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3) A Textbook of Mechatronics ,R.K.Rajput, S. Chand & Company Private Limited
4) Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall
5. Mechatronics – M.D.Singh & Joshi, Prentice Hall of India.
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Computer Aided Design

Course Code	PE ME 608/3
Course Title	Computer Aided Design
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Engineering Graphics and Design
Course Category	Program Elective (PE)
Number of classes	36 hours

Course Outcome:
After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Apprehend CAD system architecture.	K2
CO-2	Apply Geometric Modeling.	K3
CO-3	Animate engineering models.	K5
CO-4	Employ CAD standards.	K4

Course Content:
Module 1: Fundamentals of Computer Graphics:(10 hours)
Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation

Module 2: Geometric Modeling :(10 hours)

Geometric Modeling- representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Techniques of surface modelling, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep.

Module 3: Visual realism: (8 hours)
Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation.

Module 4: Assembly modelling and CAD standards: (8 hours)

Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interefence checking CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards

References / Suggested Learning Resources:

1. 1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Gra[hics, McGraw Hill, 1989. 4. D. Hearn and M.P> Baker, Computer Graphics, Prentice Hall Inc., 1992.

Mini Project

Course Code	PR ME 609
Course Title	Mini Project
Number of Credits	3 (L: 0, T: 0, P: 6)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	70 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate a through and systematic understanding of project contents	K-2
CO-2	Identify the methodologies and professional way of documentation and communication	K-3
CO-3	Illustrate the key stages in development of the project	K-2
CO-4	Develop the skill of working in a Team	K-3
CO-5	Apply the idea of mini project for developing systematic work plan in major project	K-3

Course Content:-

The mini project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Perform detailed study about various components of a project.
2) Study about methodologies and professional way of documentation and communication related to project work.
3) Develop idea about problem formulation.
4) Knowledge of how to organize, scope, plan, do and act within a project thesis.
5) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
6) Demonstrate the implementation of a mini project work.

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Tripura University
(A Central University)

Curriculum

For

B. Tech in Mechanical Engineering

(7th Semester)

2021

7th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Total Marks
1.	Program Elective-2	PE ME 701/1	1.Power Plant Engineering	3	0	0	3	3	100
		PE ME 701/2	2.Robotics	3	0	0			
		PE ME 701/3	3.Tribology	3	0	0			
2.	Program Elective-3	PE ME 702/1	1.Alternative Fuels	2	0	0	2	2	100
		PE ME 702/2	2.Energy Conservation and Management	2	0	0			
		PE ME 702/3	3 Advanced Casting Processes	2	0	0			
3.	Open Elective-1	OE ME 703	Refer Annexure-I	3	0	0	3	3	100
4.	Open Elective-2	OE ME 704	Refer Annexure-II	2	0	0	2	2	100
5.	Project - 2	PR ME 705	Project Work Intermediate	0	0	12	12	6	200
6.	Summer Internship-2	SI ME -706	Internship - II	0	0	0	0	1	100
7.	Seminar - 1	SE ME 707	Seminar on Contemporary Engineering Topics - I	0	0	2	2	1	100
Total :				10	0	14	24	**18**	**800**

Power Plant Engineering

Course Code	PE ME 701/1
Course Title	Power Plant Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Thermodynamics, Thermal Engineering
Course Category	Program Elective (PE)

Number of classes	38 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.	K2
CO-2	Analyze the layout and working of the components inside a thermal, diesel and gas turbine power plants.	K4
CO-3	Apply the knowledge of nuclear engineering& hydro electric power plants to solve practical problems.	K3
CO-4	Explain the layout, construction and working of the components inside renewable energy power plants	K2

Course Content:

Module 1: Introduction, Economics &Environmental Issues of Power Plant: (09 hours)

Power plant-Introduction, Classification - Location of power plant- Choice of Power PlantTerminology used in power plant: Peak load, Base load, Load factor, Load curve, demand factor- Various factor affecting the operation of power plant- Load sharing- cost of powertariff methods-factors involved in fixing of a tariff,Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

Module 2: Thermal, Diesel & Gas Turbine Power Plant: (10 hours)

Rankine cycle – improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.Diesel & Brayton Cycle – Analysis & Optimization. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants.

Module 3: Nuclear & Hydro Electric Power Plant: (09hours)

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), safety measures for nuclear power plants, hydro electric power plants – classification, typical layout and associated components including turbines, working, mini and micro hydel plants.

Module 4: Power From Renewable Energy: (10hours)

Solar power plant-introduction-layout, Solar cell fundamentals & classification – maximum power point tracker (MPPT) and solar panel. Wind power plant: introduction, -Factors affecting distribution of Wind energy, Variation of wind speed with height and time-Horizontal axis wind turbine (HAWT)-types of rotors,Vertical axis wind turbine- types of rotors- Wind energy conversion system (WECS) advantages and disadvantages-limitations of Wind power plant, working of tidal, geo thermal, biogas and Fuel Cell power systems.

References / Suggested Learning Resources:

1. P. K. Nag, *Power plant engineering*, McGraw Hill.
2. A K Raja, Amit Prakash Srivastava and Manish Dwivedi, *Power Plant Engineering*, New age international Publishers.

3. M.M. EL-Wakil, *Power plant technology*, McGraw Hill.

4. R K Rajput, *A Text Book of Power Plant Engineering*, Laxmi Publications.
5. James H. Rust, *Nuclear Power Plant Engineering,* Haralson Publishing Company.
6. Bernhardt G A Sarotzki, William A Vopat, *Power Station Engineering and Economy*, Tata Mc Graw Hill.
7. Dr. P.C. Sharma, *Power Plant Engineering*, S.K. Kataria & Sons.
8. Paul Breeze, *Power Generation Technologies*, Elsevier Ltd., 2014.
9. Godfrey Boyle, *Renewable energy*, Open University, Oxford University Press in association withtheOpenUniversity, 2004.

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Robotics

Course Code	PE ME 701/2
Course Title	Robotics
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Engineering Mathematics
Course Category	Program Elective (PE)
Number of classes	36 hours

Course Outcome:

After successful completion of this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Understand the fundamentals of robotics and robot	K2
CO-2	Demonstrate the classification & specifications of industrial robots	K4
CO-3	Explain robot anatomy & functions of different parts of industrial robot.	K4
CO-4	Evaluate the positions in space of manipulator by kinematic and dynamics of robot arm.	K5
CO -5	Explain the fundamentals of robot control system and programming languages	K4

Course Content:

Module 1: Fundamentalof Robotics: (9 hours)

Robotics- Fundamental and definition, Laws of robotics, Robot- definition and functions. History of robot development. Differences between a robot and an automated machine. Advantages and disadvantages of robots. Classification of industrial robots, Understanding the working principles of robot joints and basic motions, Modern industrial robots with examples and scope of work, Introduction to robot with artificial intelligence.

Module 2:Robot Anatomy: (9 hours)

Robot anatomy- Architecture of industrial robots, Robot actuators- Definition, classification, working principle and problems, Robot sensors - Definition, classification and working principle, Robot end effectors -Definition, classification and working principle, Robot specifications –Definition, applicationand problems.

Module 3: Robot Vision System: (9 hours)

Robot vision system- functions and industrial applications, Robot arm kinematics – fundamentals and problem analysis, Robot arm dynamics- fundamentals and problem analysis.

Module 4:Robot Control System &Languages:**(9 hours)**
Robotcontrol system – Fundamentals, classification, mathematical model, block diagram and application, Robot languages – Fundamentals, classification, features of some common robot languages.

Suggested Learning Resources- Text/ References

1. M.P. Groover, Industrial Robotics, Mc Graw Hill.
2. Robotic Engineering – An Integrated Approach, Richard D Klafter
3. Control System Engineering, I.J. Nagrath and Gopal
4. Saha, Introduction to Robotics, Mc Graw Hill
5. Tsuneo Yoshiklawa, Foundation of Robotics, MIT Press
6. Spong M.W. and Vidyasagar M., Robot dynamics and Control, John Wiley and Sons

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Engineering Tribology

Course Code	PC ME 701/3
Course Title	EngineeringTribology
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Program Elective(PC)
Number of classes	36 hours

Course Outcome:-
After completion of the course, students will be able to:

CO No	CO Description	K-level
CO-1	Understand the fundamentals of tribology.	K2
CO-2	Explain the Role of friction and wear, mechanism.	K2
CO-3	Apply the knowledge of hydrostatic lubrication.	K3
CO-4	Analyze the requirements and design hydrodynamic journal bearings.	K4

Course Content:-

Module 1*:* Introduction to tribology:(9 hours)

Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants.

Module 2:Friction and wear: (9 hours)

Role of friction and laws of static friction, causes of friction, theories of friction, Laws of rolling friction; Friction of metals and non-metals; Friction measurements. Definition of wear, mechanism of wear, types and measurement of wear, friction affecting wear, Theories of wear; Wear of metals and non-metals.

Module 3:Hydrostatic lubrication:(9 hours)

Principle of hydrostatic lubrication, General requirements of bearing materials, types of bearing materials., Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, Hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing, optimum design of hydrostatic step bearing.

Module 4:Hydrodynamic lubrication: (9 hours)

Principle of hydrodynamic lubrication, Various theories of lubrication, Petroff's equation, Reynold's equation in two dimensions -Effects of side leakage - Reynold's equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl, anti –friction bearing, hydrodynamic thrust bearing

References/ Suggested Learning Resources: -

1. Introduction to Tribology, B. Bhushan, John Wiley & Sons, Inc., New York.
2. Engineering Tribology, PrasantaSahoo, PHI Learning Private Ltd, New Delhi.
3. Engineering Tribology, J. A. Williams, Oxford Univ. Press
4. Introduction to Tribology in bearings, B. C. Majumdar, Wheeler Publishing.
5. Tribology, Friction and Wear of Engineering Material, I. M.Hutchings, Edward Arnold, London.
6. Engineering Tribology, G. W. Stachowiak and A. W. Batchelor, Butterworth-Heinemann.
7. Friction and Wear of Materials, Ernest Rabinowicz, John Wiley & sons.
8. Basic Lubrication Theory, A. Cameron, Ellis Hardwoods Ltd., UK.
9. Handbook of tribology: materials, coatings and surface treatments, B.Bhushan, B.K. Gupta, McGraw-Hill.

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Alternative Fuels

Course Code	PE ME 702/1
Course Title	Alternative Fuels
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	I C Engine
Course Category	Program Elective(PE)
Number of classes	24 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Explain alcohols as IC engine fuels	K2
CO-2	Discuss vegetable oils asIC engine fuels.	K2
CO-3	DescribeHydrogen as Engine Fuel.	K2
CO-4	Compare natural gas and LPG as IC engine fuels.	K6

Course Content:-

Module 1*:* Alcohols as Fuels: (6 hours)

Introduction to alternative fuels, Need for alternative fuels, Availability of different alternative fuels for SI and CI engines. Alcohols as fuels. Properties of alcohols as fuels. Methods of using alcohols in CI and SI engines. Blending, dual fuel operation,Performance emission and combustion characteristics in CI and SI engines.

Module 2:Vegetable Oils as Fuels (6 hours)

Various vegetable oils and their important properties. Different methods of using vegetable oils engines, Blending, Transesterification of Vegetable oils,Biodiesel,Performance, Emission and Combustion.

Module 3:Hydrogen as Engine Fuel: (6 hours)

Combustive properties of hydrogen. Problems associated with hydrogen as fuel and solutions. Different methods of using hydrogen in SI and CI engines. Performance, emission and combustion analysis in engines. Hydrogen storage - safety aspects of hydrogen.

Module 4:Natural Gas and LPG as Fuels: (6 hours)

Natural gas and LPG. Properties studies. Modification required to use in SI and CI Engines- Performance and emission characteristics of NG and LPG in SI and CI engines.

References/ Suggested Learning Resources: -

1. Alternate Fuels by Dr. S. Thipse, Jaico Publications
2. "Automotive Emission Control" by Crouse and Anglin – McGraw Hill.
3. "Alternative Fuels Guidebook" by Bechtold R..
4. SAE Paper nos. 840367, 841333, 841334.
5. "Internal Combustion Engines" by Ganeshan – Tata McGraw Hill.
6. "Internal Combustion Engines" by Heywood John.
7. The properties and performance of modern alternative fuels" – SAE Paper no. 841210
8. The Biodiesel Handbook, Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, AOCS Press Champaign, Illinois.
9. Alternative Fuels Guide book,Richard L Bechtold P.E., Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.
10. Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).
11. Science direct Journals (Biomass & Bio energy, Fuels, Energy, Energy conversion Management, Hydrogen Energy, etc.) on biofuels.

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Energy Conservation and Management

Course Code	PEME 702/2
Course Title	Energy Conservation and Management
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	NIL
Course Category	Program Elective (PE)
Number of classes	26 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Explain the energy auditing process with the help of energy auditing instruments.	K2
CO-2	Point out the scope of energy conservation in electrical systems.	K4
CO-3	Apply the energy conservation principle in thermal systems.	K3
CO-4	Analyze major utilities through energy conservation and management.	K4

Course Content:

Module 1: Introduction: (04 hours)

Introduction to energy & power scenario of world, National Energy consumption data,environmental aspects associated with energy utilization; Energy Auditing- need, types,methodology and barriers, role of energy managers, instruments of energy auditing.

Module 2: Electrical Systems: (08 hours)

Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors,power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

Module 3: Thermal Systems: (06 hours)

Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energyconservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories

Module 4: Energy Conservation In Major Utilities & Energy Economics: (08 hours)

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration & Air Conditioning Systems, Cooling Towers, DG sets.

Discount Period, Payback Period, Internal Rate of Return, Net Present Value; Life Cycle Costing- ESCO concept.

References / Suggested Learning Resources:

1. Witte L.C. , Schmidt P.S. and Brown D.R., *Industrial Energy Management and Utilization*,Hemisphere Publ., Washington, 1988..
2. Callaghn P.W., *Design and Management for Energy Conservation*, Pergamon Press, Oxford, 1981.
3. Murphy W.R. and McKay G., *Energy Management*, Butterworths, London, 1987.
4. *Energy Manager Training Manual* , Bureau of Energy Efficiency (BEE) under Ministry of Power,GOI, 2004 (available at www.energymanager training.com).
5. Dryden. I.G.C., *The Efficient Use of Energy*, Butterworths, London, 1982

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Advanced Casting Processes

Course Code	PEME 702/3
Course Title	Advanced Casting Processes
Number of Credits	2(L: 2, T:0, P: 0)
Prerequisites	Nil
Course Category	Program Elective
Number of classes	26 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	understand the principles of advanced casting techniques.	K2
CO-2	explain the recent development in casting techniques with their specific advantages & disadvantages.	K3
CO-3	design a gating system for a casting.	K5
CO-4	explain about the casting materials and testing procedures.	K3

Course Content:

Module 1: Solidification, Gating and Riser design & analysis(7 hours)

Equipment in foundry,Patterns, Materials used in moulds -Sands, Resins and other materials, Nucleation and grain growth, Solidification of pure metals,Rate of solidification,Gating system design - Pouring time, Choke Area, Sprue,Other gating elements. Risering design - Caine's Method, Modulus Method, Feeding distances,Chills, Feeding Aids.Related Numerical problems.

Module 2: Castings Materials, Melting and Quality Control(7 hours)

Ferrous-Steel Casting, Grey iron foundry practice, Ductile iron ,Malleable Iron etc. Non Ferrous-Considerations when casting materials are Aluminium, Copper, Magnesium and Zinc etc. Melting processesofferrous and non-ferrous alloys.Casting defects, fettling, heat treatment &inspection, and testing of castings.

Module 3: Centrifugal and Investment Casting (6 hours)

Principle of centrifugal casting process and its different types; different techniques and equipment used in centrifugal casting process; advantages and disadvantages of this process and Products applications. Principle of investment casting process and its different types; different techniques used in investment casting process**;** advantages, disadvantages and applications of this process.

Module 4: Die Casting and other Recent Developments (6 hours)

Principle of die casting process and its different types; different equipments used in die casting process and there operations and descriptions; advantages and disadvantages of this process. Low pressure And high pressure die casting, Squeeze casting, Rheocasting.

References / Suggested Learning Resources:

1. P.N.Rao, Manufacturing Technology, Tata McGraw Hill, 2008.
2. Heine, Loper and Rosenthal, Principles of Metal Casting, Tata McGraw Hill, 2001
3. A.K. Chakrabarti, Casting Technology and Cast Alloys, PHI, 2005
4. T.V.Rama Rao, Metal casting Principles and Practice, New Age International, 2010

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Thermal Engineering

Course Code	OEME 703
Course Title	Thermal Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	NIL
Course Category	Open Elective (OE)
Number of classes	36 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Explain the basics of different modes of heat transfer	K2
CO-2	Summarize the principles of refrigeration &air conditioning.	K2
CO-3	Analyze the velocity diagram and compounding of steam turbine.	K4
CO-4	Compare gas turbine with intercooling, reheat & regeneration	K4

Course Content:

Module 1: Basics of Heat Transfer: (09 hours)

Conduction: Fourier's Law of heat conduction – Thermal Conductivity. Heat transfer through plane homogeneous wall, through composite wall and through hollow cylinder. **Convection:** Explanation of Convective heat transfer, Principle of heat exchanger, classification of heat exchangers, overall heat transfer coefficient and fouling factor. Concepts of LMTD and NTU methods and problems using these methods. **Radiation:** Explanation of heat transfer by radiation, definition of absorptivity, reflectivity, transmissivity, Black Body. Emission characteristics, and laws of black body radiation, Irradiation of total and monochromatic quantities, Heat exchange between two black bodies, concepts of shape factor

Module 2: Refrigeration &Air Conditioning: (09 hours)

Reversed Carnot Cycle, Bell-Coleman Cycle, deviation from actual cycle. Vapour Compression Refrigeration Cycle. Electrolux Refrigerator. Refrigerants - designation and trade name; Physical, Chemical & Thermodynamic properties of principal refrigerants. Effective temperature, comfort chart, ventilation requirements. Psychometrics chart, air humidity processes, humidification & dehumidification, By-pass factor.

Module 3: Steam Turbine: (09 hours)

Classification of Steam Turbine, Simple Impulse Turbine – Working Principle, Velocity Diagram, Parts of Steam Turbine (Location & Function), blade efficiency, optimum velocity ratio, multistaging & its

advantages, velocity compounded impulse turbine, reheat factor. Compounding of Turbine, Working Principle of Reaction Turbine, Concept of Reheating and Regenerating.

Module 4: Gas Turbine: (09 hours)

Open cycle gas turbine with intercooling, reheat & regeneration, Effect of intercooling to reheat & regeneration on efficiency, Effect of operating variable on thermal efficiency on Air Rate & on Work Ratio. Closed cycle gas turbine, Advantages of closed cycle gas turbine over the open cycle gas turbine. Advantages & disadvantages of gas turbine over steam turbine power plants**.**

References / Suggested Learning Resources:

1. Khurmi R.S. and Gupta J.K,*A Textbook of Thermal Engineering*, S. Chand.

2. R.K. Rajput, *Thermal Engineering* , Laxmi Publications.

3. P. N. Ananthanarayan, *Basic Refrigeration and Air Conditioning*, Tata McGraw Hill, ISBN- 9789383286560.

4. A.CenegelYunus, *Heat Transfer A Practical Approach*, Tata McGraw Hill

5. Soman, *Thermal Engineering*, PHI.

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Total Quality Management

Course Code	OEME 704
Course Title	Total Quality Management
Number of Credits	2 (L: 2, T:0, P: 0)
Prerequisites	NIL
Course Category	Open Elective (OE)
Number of classes	26 hours

Course Outcome:

CO Number	CO Description	K Level
CO 1	Understanding quality management philosophies, techniques, and frameworks	**K2**
CO 2	Analyzing the understanding of TQM principles and processes	**K4**
CO 3	Apply tools and techniques of TQM in manufacturing and service sectors	**K3**
CO 4	Expressing knowledge about various aspects of quality and TQM	**K3**

CourseContent:

Module 1:Introduction(6 Hours)

Needforquality,DefinitionofQuality,Evolutionof quality,ProductqualityandServicequality,DimensionsofQuality, DefinitionofTotalqualitymanagement,QualityPlanning,Quality costs-Analysis,TechniquesforQualityCosts,andBasicconceptsof Total Quality Management. QualityCouncil,QualityStatements,Strategicqualityplanning, BarrierstoTQMImplementation,BenefitsofTQM,Contributionsof Deming, Juran and Crosby.

Module 2:TQMPrinciples(6 Hours)
Customersatisfaction-CustomerPerceptionof Quality,CustomerComplaints,ServiceQuality.CustomerRetention; Employeeinvolvement,motivation;Empowerment;Teamand Teamwork;Qualitycircles,recognitionandreward,performance appraisal;Continuousprocessimprovement;PDCAcycle,5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

Module 3:TQM Tools and Techniques (10 Hours)
Benchmarking- Reasons to Benchmark,BenchmarkingProcess;QualityFunctionDeployment (QFD);TaguchiQualityLossFunction;Seventraditionaltoolsof quality;Newmanagementtools;Processcapability;Sixsigma-concepts,methodology;TPM-concepts,improvementneeds, performance measures; FMEA- Stages of FMEA.

Module 4:QualitySystems (4 Hours)
NeedforISO9000andOtherQualitySystems, ISO9001:2015QualitySystem-Elements,Documentation;Quality Auditing, QS 9000, ISO 14000- Concept, Requirements and Benefits; TQM implementation in manufacturing and service sectors

LearningResources:
1.D.H.Besterfield,C.Besterfield,G.H.Besterfield,M.Besterfield,H.Urdhwaresheand R. Urdhwareshe, Total Quality Management, Pearson Education, 2018.
2.A. Mitra, Fundamentals of Quality Control and Improvement, Wiley Student Edition, 2008.
3.S. Ramasamy, Total Quality Management, McGraw Hill Publishing Co., New Delhi, 2011.
4.J.R.EvansandW.M.Lindsay,TheManagementandControlofQuality,CengageLearning,1999.
5.D.C. Montgomery, Introduction to Statistical Quality Control, John Wiley, 2019.
6.M.P. Poonia, Total Quality Management, Khanna Book Publishing, 2018.

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Project Work Intermediate

Course Code	PR ME 705
Course Title	Project Work Intermediate
Number of Credits	6 (L: 0, T: 0, P: 12)
Prerequisites	Nil
Course Category	Project (PR)

Number of classes	130 hours

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Demonstrate a sound technical knowledge of their selected project topic	K-2
CO-2	Develop the skill of working in a Team	K-3
CO-3	Design engineering solutions to complex problems utilizing a systematic approach	K-6
CO-4	Design the solution of an engineering project involving latest tools and techniques	K-6
CO-5	Develop the skill of effective communication with engineers and the community at large in written an oral forms	K-3
CO-6	Demonstrate the knowledge, skills and attitudes of a professional engineer	K-2

Course Content:-

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Develop sound knowledge about the domain of the project work.
2) Perform detailed study about various components of a project.
3) Learn to be an important member of a team for successful execution of a project work.
4) Study about methodologies and professional way of documentation and communication related to project work.
5) Develop idea about problem formulation, finding the solution of a complex engineering problem.
6) Develop project report as per the suggested format to communicate the findings of the project work.
7) Acquire the skill of effective oral communication to the fellow engineers and people in the society at large.
8) Develop knowledge of how to organize, scope, plan, do and act within a project thesis.
9) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
10) Demonstrate the implementation of a project work.

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Industry Internship – II

Course Code	SI ME 706
Course Title	Industry Internship – II
Number of Credits	1 (L: 0, T: 0, P: 0)

Prerequisites	Nil
Course Category	Summer Internship (SI)
Number of classes	-

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Solve real life challenges in the workplace by analysing work environment and conditions, and selecting appropriate skill sets acquired from the course of study	K-3
CO-2	Develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting	K-3
CO-3	Demonstrate the skill to communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means	K-2
CO-4	Show professional ethics by displaying positive disposition during internship	K-2
CO-5	Decide career options by considering opportunities in company, sector, industry, professional and educational advancement	K-5

Course Content:-

The industry internship aims to provide the student with:

1. A practice-oriented and 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.

2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting.

3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real world work environment.

4. Pre-employment training opportunities and an opportunity for the company or organisation to assess the performance of the student and to offer the student an employment opportunity after his/her graduation, if it deems fit.

Each student shall

1) Identify an internship program of relevance in his/her branch of engineering to undergo during summer break between 6^{th} and 7^{th} semester,

2) Get approval of the concerned HOD,

3) Undergo the industry internship program for minimum 4 weeks duration

4) Prepare their own report

5) Present in the class among fellow students and faculty members / deliver viva voce.

6) Submit the report and participation/course completion certificate.

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Seminar on Contemporary Engineering Topics – I

Course Code	SE ME 707
Course Title	Seminar on Contemporary Engineering Topics – I
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Seminar (SE)
Number of classes	24 hours

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Identify contemporary topics in respective branch of engineering	K-3
CO-2	Survey literature to understand insight of the selected topic	K-4
CO-3	Develop report writing and presentation making skill	K-3
CO-4	Present the topic so prepared among audience using suitable aid	K-3

Course Content:-

Each student shall

1) Identify a topic of current relevance in his/her branch of engineering,

2) Get approval of the faculty concerned/HOD,

3) Collect sufficient literature on the selected topic, study it thoroughly (literature survey),

4) Prepare their own report and presentation slides and

5) Present in the class among fellow students and faculty members.

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Tripura University
(A Central University)

Curriculum

For

B. Tech in Mechanical Engineering

(8th Semester)

2021

8th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Total Marks
1.	Program Elective-4	PE ME 801/1	1.Welding and Allied Processes	3	0	0	3	3	100
		PE ME 801/2	2.Non-Traditional Machining						
		PE ME 801/3	3.Production Engineering						
2.	Program Elective-5	PE ME 802/1	1.Automobile Engineering	2	0	0	2	2	100
		PE ME 802/2	2.Operation Research						
		PE ME 802/3	Gas Dynamics & Jet Propulsion						
3.	Open Elective-1	OE ME 803	Refer Annexure-III	3	0	0	3	3	100
4.	Open Elective-2	OE ME 804	Refer Annexure-IV	2	0	0	2	2	100
5.	Project - 3	PR ME 805	Project Work Final	0	0	12	12	6	200
6.	Seminar - 2	SE ME 806	Seminar on Contemporary Engineering Topics - II	0	0	2	2	1	100
7.	Online Course	SW ME 807	SWAYAM Courses	0	0	0	0	1	100
			Total :	10	0	14	24	**18**	**800**

Welding and Allied Processes

Course Code	PE ME 801/1
Course Title	Welding and Allied Processes
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Primary manufacturing processes
Course Category	Program Elective (PE)
Number of classes	36 hours

Course Outcome:

After successful completion of this course, the students will be able to

CO Number	CO Description	K-level
CO-1	differentiate thevarious welding processes with related advantages in the applied field	K2
CO-2	select the type of welding process required for a specific application	K3
CO-3	demonstrate the welding defects and their related issues	K4
CO-4	analyze the heat effect in welding with associated welding metallurgy (K4)	K4

Course Content:

Module 1: Introduction:(9 hours)

Welding- Introduction and classification, Selection of welding processes, Electrodes and filler metal - classification and uses, Weld joint- joint preparation, classification and symbols, Gas tungsten arc (TIG) welding – working principle and application, Gas metal arc (MIG) welding – working principle and application, Submerged arc welding-working principle and application, Electro slag welding - working principle and application, Resistance welding -working principle and application,

Module 2: Welding Processes & Application:(9 hours)

Solid state welding processes - fundamentals and classification. Working principle and application of Friction welding, Forge welding, Diffusion bonding, Ultrasonic welding and Explosion welding. Underwater welding - working principle and application, Laser beam welding - working principle and application, Electron beam welding-working principle and application, Plasma arc welding- working principle and application, Welding of dissimilar metals-Fundamentals and application.

Module 3: Testing ofWeldment: (9 hours)

Weldment Testing – Defects in welding, causes and remedies, Destructive testing of weldments- Strength, hardness, ductility, fatigue, creep properties etc. Non-destructive testing of weldments- Liquid penetrant testing, Magnetic particle testing, Radiographic testing, Ultrasonic testing. Pressure and leak testing in boilers, pressure vessels, pipe line etc. Welding residual stresses- Fundamentals, classification, causes and remedies.

Module 4:Welding Metallurgy: (9 hours)

Weldability – Definition, factors affecting weldability, Weldability tests- Murex test, Varestraint test, Lehigh restraint test, Longitudinal bead-weld test, Heat flow in welding – fundamental analysis and problems, Weld thermal cycle – effect of welding heat input, critical cooling time calculation and importance, Welding metallurgy of fusion welds, Allied processes - joining processes, metal depositing processes, thermal cutting processes.

Suggested Learning Resources- Text/ References

1. R.S. Parmar, Welding Engineering and Technology, Khanna Publishers.
2. Radhakrishnan,V.M., Welding Technology and Design, New Age International Pvt. Ltd.

3. Little R.L., Welding Technology, Tata McGraw- Hill.
4. Rao.P.N., Manufacturing Technology, Tata McGraw- Hill.
5. Abbot.J., Smith.K.M, Welding Technology, Texas State Technical College Publishing.

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Non-Traditional Machining

Course Code	PE ME 801/2
Course Title	Non-Traditional Machining
Number of Credits	3(L: 3, T: 0, P: 0)
Prerequisites	---
Course Category	Program Elective (PE)
Number of classes	36 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Understand the compare traditional and non-traditional machining process and recognize the need for non-traditional machining and the constructional features, performance parameters, process characteristic, applications, advantages and limitations of USM, AJM and WJM.	K3
CO-2	Understand the constructional features of the equipments, performance parameters, process characteristic, applications, advantages and limitations of EDM and PAM.	K3
CO-3	Identify the need of Chemical and Electro-chemical Machining process along with the constructional features of the equipments, performance parameters, process characteristic, applications, advantages and limitations.	K4
CO-4	Understand the LBM equipments, LBM parameters and characteristic. EBM equipment and mechanism of metal removal, applications, advantages and limitations of LBM and EBM.	K3

Course Content:-

Module 1: Introduction and Mechanical Process (12 hours)

Need of Non-Traditional Machining Processes – Classification Based on Energy, mechanism, source of energy, transfer media and process. Process selection - based on physical parameters, shapes to be machined, process capability and economics.

Ultrasonic Machining: Principle- Transducer types – Concentrators - Abrasive Slurry – Process Parameters – Tool Feed Mechanism – Material Removal Rate - Advantages and Limitations – Applications.

Abrasive Jet Machining: Process- Principle – Process Variables – Material Removal Rate - Advantages and Limitations – Applications.

Water Jet Machining: Principle – Process Variables – Advantages and Limitations – Practical Applications – Abrasive water jet machining process.

Module 2: Electrical Discharge Machining (8 Hours)

Electrical Discharge Machining: Mechanism of metal removal – Dielectric Fluid – Flushing methods - Electrode Materials - Spark Erosion Generators – Electrode Feed System – Material Removal Rate – Process Parameters – Advantages and Limitations – Practical Applications.
Plasma Arc Machining: Principle –Gas mixture– Types of Torches – Process Parameters - Advantages and Limitations – Applications.

Module 3: Chemical and Electro Chemical Machining (8 hours)
Chemical Machining: fundamentals, Principle –classification and selection of Etchant –chemical milling, Engraving, Blanking - Advantages and limitations – Applications.
Electro Chemical Machining: Electro-chemistry of the process-Electrolytes - Electrolyte and their Properties – Material Removal Rate – Tool Material – Tool Feed System – Advantages and Limitations – Applications.
Electro Chemical Grinding: Honing, cutting off, deburring and turning.

Module 4: High Energy Machining Process (8 hours)
Electron Beam Machining: Principle – Generation and control of electron beam-Advantages and Limitations – Applications.
Laser Beam Machining: Principle –Solid and Gas Laser Application – thermal features of LBM - Advantages and Limitations – Applications.
Ion Beam Machining: Equipment – process characteristics - Principle – MRR – Advantages and Limitations – Applications.

Text Books / References:
1. P.C Pandey And H.S. Shan, "Modern Machining Process", Tata Mc Graw – Hill Publishing Company Limited, New Delhi.
2. V.K. Jain, "Advanced Machining Process", Allied Publishers Pvt Limited.
3. Amithaba Bhattacharyya, "New Technology", The Institution of Engineers (India).
4. "Production Technology", HMT Bangalore, Tata Mc Graw–Hill Publishing Company Limited, New Delhi.
5.Modern Machining Process by P.C Pandey and H S Shah McGraw Hill Education India Pvt. Ltd.2000.

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Production Technology

Course Code	PE ME 801/3
Course Title	Production Technology
Number of Credits	3 (L: 3, T:0, P: 0)
Prerequisites	Nil
Course Category	Program Elective
Number of classes	36 hours

Course Outcome:
After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	ComprehendManufacturing science and Recent advances in manufacturing technology.	K2
CO-2	Distinguish Mechanization& automation and Automated Machine Tools.	K2
CO-3	Analyze Product Development & Design.	K4

CO-4	Evaluate the Assembly line balancing.	K5

Course Content:

Module 1: Manufacturing science and advances in manufacturing technology: (10 hours)

Manufacturing science & its application to mass production. Machining allowances, machining accuracy, surface finish. Different mass production techniques-both chip forming & non chip forming- their advantages & disadvantages. Recent advances in manufacturing technology-Non-conventional machining processes.

Module 2: Mechanisation& automation, Automated Machine Tools:(8 hours)

Mechanisation& automation of manufacturing & assembly lines. Machining & tooling for mass production-Jigs & Fixtures design. Locating, clamping, guiding, indexing devices. Hydropneumatic devices. Tooling economics.

Automated Machine Tools, Numerically controlled machines, CNC machines, their construction, components & operation, part programming for CNC machines. Advantages & disadvantages of CNC machines.

Module 3: Product Development & Design: (8 hours)

Manufacture of typical machine parts, e.g. screw threads, gears, housing. machine beds, engine components. Product Development & Design, Production Design-productibility consideration of product & components, value engineering process planning, group technology. Manufacturing Costs, Break-Even Analysis, Economic Batch Quality, Economics of Metal Removal, Economics of material utilization.

Module 4: Production Planning & Control: (10 hours)

Production Planning & Control, sequencing & scheduling, processing of "n" jobs through two machines, processing of "n" jobs through three machines, processing of two jobs through "n" machines, Assignment Models.

Assembly line balancing Theory, Ranked positional weight technique of Assembly line Balancing. Computerized method of sequencing operations for Assembly lines(COMSOAL).

References / Suggested Learning Resources:

1. Jain R.K., Production Technology, Khanna Publishers, 2001
2. Hajra Choudhry, Elements of Workshop Technology, Vol – II Dhanpat Rai & Sons, 1992.
3. HMT Production Technology, Tata Mc Graw-Hills Publishing Co. Limited, 1994.
4. Chapman, W.A.J., Workshop Technology, Vol - II, Oxford & IBH Publishing Co. Ltd., 1986.

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Automobile Engineering

Course Code	PE ME 802/1
Course Title	Automobile Engineering
Number of Credits	**2 (L: 2, T: 0, P: 0)**
Prerequisites	**Nil**
Course Category	Program Elective (PE)
Number of classes	**24 hours**

Course Outcome:

	At the end of the course, the student will be able to:	
CO1	Identify the components of an automobile with their working	K2
CO2	Diagnose the problems related to the transmission and Fuel supply.	K3
CO3	Diagnose the problems related to the steering and Suspension system.	K3
CO4	Choose proper tires and fuel for the vehicle.	K4

Course Content:

Module 1:Engine: BasicFunction and Management: (05 hours)

Concept of Engine and its classification, working of 2-Stroke and 4-Stroke SI and CI engine. Vehicle Structure and Engines-Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicleaerodynamics, IC engines-components, function and materials, variable valve timing (VVT). Review of Cooling and Lubrication systems in Engine, Turbo Chargers, Engine Emission Control by 3–Way Catalytic Controller, Electronic Engine Management System.

Module 2:Fuel Supply and Electrical System: (05 hours)

Fuel Supply in SI and CI engine: Carburetor–working principle, Electronic fuel injection system – Mono-point and Multi - Point Injection Systems, **Electrical systems** – Battery generator – Starting Motor and Drives – Lighting and Ignition (Battery, Magneto Coil and Electronic Type) - Regulators-cut outs.

Module 3:Transmission and Braking System: (08 hours)

Transmission System: Clutch – Types and Construction, Gear Boxes-Manual and Automatic, Simple Floor Mounted Shift Mechanism, Over Drives, Transfer Box, Fluid flywheel-Torque convertors, Propeller shaft – Slip Joint – Universal Joints, Differential and Rear Axle, Hotchkiss Drive and Torque Tube Drive.**Braking System :** Types and functions, pneumatic and hydraulic braking systems, antilock braking system (ABS),electronic brake force distribution (EBD) and traction control.

Module 4:Steeringand Suspension: (06 hours)

Steering and Suspension: Wheels and Tires Construction, Steering geometry and types of steering gear box, power steering, types of front axle, types ofsuspension systems,

Alternative Energy Sources-Use of Natural Gas, LPG and Biodiesel in Automobiles, hydrogen fuels in automobiles, Electric and Hybrid Vehicles, application of Fuel Cells.

References / Suggested Learning Resources:

1. Crolla, D., Automotive Engineering: Powertrain, Chassis System, Butterworth-Heinemann.
2. Heisler, H., Advanced Vehicle Technology, Butterworth-Heinemann.
3. Happian-Smith, J., An Introduction to Modern Vehicle Design, Butterworth- Heinemann.
4. Newton, Steeds and Garet, Motor vehicles, Butterworth Publishers.
5. Crouse, W. H., & Anglin, D. L., Automotive Mechanics: Study Guide, McGraw-Hill
6. Automotive Mechanics,2nd ed., Joseph Heitner, East West Press 1999
7. Automotive Mechanics, S. Srinivasan, 2nd Edition, Tata McGraw Hill
8. Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 1997.

Operations Research

Course Code	PE ME 802/2
Course Title	Operations Research
Number of Credits	2 (L: 2, T: 0, P: 0)

Prerequisites	Mathematics
Course Category	Program Elective(PC)
Number of classes	24 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Formulate and solve Linear programming Problems.	K5
CO-2	SolveTransportation and Assignmentproblem.	K3
CO-3	Calculate Economic order quantity and queue length.	K3
CO-4	Evaluate the value of games and critical path.	K6

Course Content:-

Module 1*:* Linear Models: (6 lectures)

Introduction to Operation Research, characteristics and the phases of an operation research scope and applications of Operation Research, techniques used, Linear programming: Formulations of linear programs, graphical method, simplex method.

Module 2:Transportation and Assignment Models:(6 lectures)

Transportation Models, formulation of mathematical model, solution of Transportation problem by different method. Assignment Models, formulation of mathematical model, solution of different types of Assignment problems, Traveling Salesman problem.

Module 3:Inventory and QueueingModels: (6 lectures)

Inventory models, Economic order quantity models, Quantity discount models. Multi product model, Inventory control models in practice. Queueing models, Queueing systems and structures, Notation parameter, Single server and multi-server models, Poisson input, Exponential service,

Module 4:Decision Models: (6 lectures)

Game theory, Two-person zero sum games, Graphical solution- Algebraic solution, Linear Programming solution.Networks models, Project network, CPM and PERT networks, Critical path.

References/ Suggested Learning Resources: -

1. Taha, H.A., “Operations Research”, Prentice Hall of India, Sixth Edition, 2003.
2. Sharma, J. K., Operation Research: Theory and Applications, Macmillan Publishers.
3. Swarup, K., Gupta, P. K.,“Operations Research”, Sultanchand Publisher.
4. Ravindran, Phillips and Solberg, Operations Research: Principles and practices, John Wiley.
5. Tulsian and Pasdey V., “Quantitative Techniques”, Pearson – Asia.
6. Bronson and Naadimuthu, Operations Research – Schaum’s Outline Series, McGraw-Hill.

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Gas Dynamics & Jet Propulsion

Course Code	PE ME 802/3
Course Title	Gas Dynamics & Jet Propulsion

Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Thermodynamics, Fluid Mechanics.
Course Category	Program Elective (PE)
Number of classes	26 hours

Course Outcome:

After completing this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Explain the basic principle of compressible flow.	K2
CO-2	Analyze the Rayleigh flow and Fanno flow.	K4
CO-3	Apply the knowledge ofjet propulsion to solve practical problems.	K3
CO-4	Summarize rocket propulsion system.	K5

Course Content:

Module 1: Compressible flow: (08 hours)

Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow, Isentropic flow through variable area ducts, nozzles and diffusers, subsonic and supersonic flow through variable area ducts, choked flow, Area-Mach number relations for isentropic flow.

Module 2: Non-isentropic flow: (06 hours)

Non-isentropic flow in constant area ducts, Rayleigh and Fanno flows, Normal shock relations, oblique shock relations, isentropic and shock tables

Module 3: Jet propulsion: (06 hours)

Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

Module 4: Rocket engines: (06 hours)

Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights

References / Suggested Learning Resources:

1. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press, 2008.
2. H.S. Mukunda, “Understanding Aerospace Chemical Propulsion”, Interline Publishing, 2004.
3. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley, 1992.
4. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley, 1975.
5. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986.

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Basics of Robotics

Course Code	OE ME 803
Course Title	Basics of Robotics
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Engineering Mathematics
Course Category	Program Elective (PE)
Number of classes	36 hours

Course Outcome:

After successful completion of this course, the students will be able to

CO Number	CO Description	K-level
CO-1	Understand the fundamentals of robotics and robot	K2
CO-2	Demonstrate the classification & specifications of industrial robots	K4
CO-3	Explain robot anatomy & functions of different parts of industrial robot.	K4
CO-4	Evaluate the positions in space of manipulator by kinematic and dynamics of robot arm.	K5
CO -5	Explain the fundamentals of robot control system and programming languages	K4

Course Content:

Module 1: Fundamental of Robotics: (9 hours)

Robotics- Fundamental and definition, Laws of robotics, Robot- definition and functions. Differences between a robot and an automated machine. Advantages and disadvantages of robots. Classification of industrial robots, Understanding the working principles of robot joints and basic motions,Introduction to robot with artificial intelligence.

Module 2: Robot Anatomy: (9 hours)

Robot anatomy- Architecture of industrial robots, Robot actuators- Definition, classification, working principle and problems, Robot sensors - Definition, classification and working principle, Robot specifications –Definition, applicationand problems.

Module 3: Robot Vision System: (9 hours)

Robot arm kinematics – fundamentals and problem analysis, Robot arm dynamics- fundamentals and problem analysis.

Module 4:Robot Control System &Languages: (9 hours)

Robotcontrol system – Fundamentals, classification,mathematical model, block diagram and application, Robot languages – Fundamentals, classification andfeatures of some common robot languages.

Suggested Learning Resources- Text/ References

1. M.P. Groover, Industrial Robotics, Mc Graw Hill.
2. Robotic Engineering – An Integrated Approach, Richard D Klafter

3. Control System Engineering, I.J. Nagrath and Gopal
4. Saha, Introduction to Robotics, Mc Graw Hill
5. Tsuneo Yoshiklawa, Foundation of Robotics, MIT Press
6. Spong M.W. and Vidyasagar M., Robot dynamics and Control, John Wiley and Sons

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Principles of Management

Course Code	OE ME 804
Course Title	Principles of Management
Number of Credits	2 (L: 2, T:0, P: 0)
Prerequisites	Basic Engineering Knowledge
Course Category	Open Elective (OE)
Number of classes	26 hours

CO And K-Level

CO Number	CO Description	K Level
CO 1	Understanding the principles of management and their application to the functioning of an organization.	**K2**
CO 2	Different aspects of work system design and facilities design pertinent to manufacturing industries	**K3**
CO 3	Understanding the role of productivity in streamlining a production system	**K4**
CO 4	Applying the inventory management tools in managing inventory	**K3**

Course Contents:

Module 1:Introduction: (5 Hours)
Definition of management, science or art, manager vs entrepreneur; Types of managers- managerial rolesand skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and privateenterprises; Organization culture and environment; Current trends and issues in management.Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, StrategicManagement, Planning Tools and Techniques, Decision making steps & processes.

Module 2:Nature and purpose of Organizing: (7 Hours)
Nature and purpose of Organizing, formal and informal organization, organization structure, types, lineand 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.

Module 3: Material Handling: (8 Hours)

Nature, Significance and Scope ofFacility layout and design; Steps in facility layout planning, Assembly Line Balancing.Material Handling: Definition, Objective and Principles of MaterialHandling, Classification of Material Handling Devices.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

Module 4:Inventory& Value Analysis:(6 Hours)
Importance and areas ofmaterials management, Introduction to Inventory: Definitions, Need for inventory, Types of inventory, Inventory costs; Structure of inventory models, Deterministic models; safety stock, inventory control systems; Selective inventory management. MRP and JIT-based production systems, Concept of zero inventory, Fundamental concepts of purchasing, storing, distribution, and value analysis & engineering.

TextBooks:

1. Robins S.P. and Couiter M., Management, Prentice HallIndia,10th ed., 2009.
2. Stoner JAF, FreemanREand GilbertDR, Management, 6th ed., PearsonEducation, 2004. 3. TripathyPC & ReddyPN, Principles ofManagement, Tata McGraw Hill, 1999.
3.C. Sharma, Industrial Engineering and Management, Khanna Book Publication, 2016.
4. O.P. Khanna, Industrial Engineering and Management, Dhanpat Rai Publication, 1980.
5. S. Ray, Introduction to Materials Handling, New Age International, 2016

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Project Work Final

Course Code	PR ME 805
Course Title	Project Work Final
Number of Credits	6 (L: 0, T: 0, P: 12)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	130 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate a sound technical knowledge of their selected project topic	K-2
CO-2	Develop the skill of working in a Team	K-3
CO-3	Design engineering solutions to complex problems utilizing a systematic approach	K-6
CO-4	Design the solution of an engineering project involving latest tools and techniques	K-6
CO-5	Develop the skill of effective communication with engineers and the community at large in written an oral forms	K-3
CO-6	Demonstrate the knowledge, skills and attitudes of a professional engineer	K-2

Course Content:-

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Develop sound knowledge about the domain of the project work.
2) Perform detailed study about various components of a project.
3) Learn to be an important member of a team for successful execution of a project work.
4) Study about methodologies and professional way of documentation and communication related to project work.
5) Develop idea about problem formulation, finding the solution of a complex engineering problem.
6) Develop project report as per the suggested format to communicate the findings of the project work.
7) Acquire the skill of effective oral communication to the fellow engineers and people in the society at large.
8) Develop knowledge of how to organize, scope, plan, do and act within a project thesis.
9) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
10) Demonstrate the implementation of a project work.

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Seminar on Contemporary Engineering Topics – II

Course Code	SE ME 806
Course Title	Seminar on Contemporary Engineering Topics – II
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Seminar (SE)
Number of classes	24 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Identify contemporary topics in respective branch of engineering	K-3
CO-2	Survey literature to understand insight of the selected topic	K-4
CO-3	Develop report writing and presentation making skill	K-3
CO-4	Present the topic so prepared among audience using suitable aid	K-3

Course Content:-

Each student shall

1) Identify a topic of current relevance in his/her branch of engineering,
2) Get approval of the faculty concerned/HOD,
3) Collect sufficient literature on the selected topic, study it thoroughly (literature survey),
4) Prepare their own report and presentation slides and

5) Present in the class among fellow students and faculty members.

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SWAYAM Courses

Course Code	SW ME 807
Course Title	SWAYAM Courses
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Online Course (SW)
Number of classes	-

Courses Outcome:- After completion of the courses, students will be able to:

CO Number	CO Description	K-level
CO-1	Make use of digital learning platform to enhance knowledge and skill beyond the prescribed curriculum structure	K-3
CO-2	Take part in proctored examination system to prepare oneself for similar future challenges	K-4
CO-3	Utilize the opportunity to learn from best faculty in the country for professional development	K-3
CO-4	Develop the skill of lifelong self-learning and become future ready	K-3

Courses Content:-

SWAYAM (Study Webs of Active-learning for Young Aspiring Minds); India Chapter of Massive Open Online Courses. SWAYAM is an indigenous developed IT platform, initiated by Government of India, which is instrumental for self-actualization providing opportunities for a life-long learning. Learner can choose from hundreds of courses, virtually every course that is taught at the university/college/school level and these shall be offered by best of the teachers in India and elsewhere. Student having registered a course, having submitting the Assignments as per requirements of the course, shall at the end of each course, be assessed through a proctored examination. A student having successfully completed the course shall get a Certificate.

Each student has to undergo and qualify at least two relevant SWAYAM or equivalent courses (to be certified by concerned HOD) with certification during the entire course of B. Tech. program. The Head of the departments will approve the relevancy of a SWAYAM or equivalent course for respective branch of engineering.

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PROGRAM OUTCOMES (POS) AS PER NATIONAL BOARD OF ACCREDITATION (NBA)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.