OFFICE OF THE REGISTRAR :: DIBRUGARH UNIVERSITY :: DIBRUGARH

Ref. No. DU/DR-A/Syllabus-B.Tech.(ME)/23/980 Date: 05.10.2023

NOTIFICATION

As recommended by the Board of Studies (BoS) in Mechanical Engineering in its meeting held on 26.07.2023, the Hon'ble Vice-Chancellor, Dibrugarh University is pleased to approve the modified syllabus of B. Tech. Programme in Mechanical Engineering from the batch of 2023 onwards.

The above is notified under report to the next meetings of the Under Graduate Board (UGB) and Academic Council, Dibrugarh University.

The modified syllabus is attached herewith.

Issued with due approval.

05/10/2023

Deputy Registrar (Academic)
Dibrugarh University.

Copy to:

1. The Hon'ble Vice-Chancellor, Dibrugarh University for kind information.
2. The Deans, Dibrugarh University, for kind information.
3. The Registrar, Dibrugarh University for kind information.
4. The Director, Dibrugarh University Institute of Engineering and Technology (DUIET), Dibrugarh University, for kind information.
5. The Head i/c, Department of Mechanical Engineering (DUIET), Dibrugarh University, for information and necessary action.
6. The Controller of Examinations i/c, Dibrugarh University for information and necessary action.
7. The Joint / Deputy Controller of Examinations -'C', 'A' and 'B' Dibrugarh University for information and necessary action.
8. The Programmer, Dibrugarh University with a request to upload the Notification in the University website.
9. File.

05/10/2023

Deputy Registrar (Academic)
Dibrugarh University

Under Graduate Degree
Courses in
MECHANICAL ENGINEERING
With Skill Based Courses

&

Minor Degree Course in Additive Manufacturing

[Proposed Syllabus – 2023 onwards]

Department of Mechanical Engineering, Dibrugarh University
Institute of Engineering and Technology
Dibrugarh University
Dibrugarh,
Assam-786004
India

General course structure
&
credit distribution

All India Council for Technical Education
Model curriculum for Undergraduate Degree Courses in Engineering &Technology

MECHANICAL ENGINEERING

A. Definition of Credit:

1 Hr.Lecture (L)per week	1 credit
1 Hr.Tutorial (T)per week	1 credit
1 Hr. Practical (P)per week 2 Hours Practical (Lab)/week	0.5 credit 1 credit

B. Range of credits-A student will be awarded **B.Tech Degree in Mechanical Engineering**, if he/she completes 169 credits. Additionally, a student will be awarded **B.Tech Degree in Mechanical Engineering with Minor in Additive Manufacturing**, if he/she completes an additional 18 credits.

C. Structure of UG Program in ME: The structure of UG program in Mechanical Engineering shall have essentially the following categories of courses with the break up of credits as given:

D.

Sl.No.	Category	Credit Breakup for ME students
1	Humanities and Social Sciences Including Management Courses	11
2	Basic Science Course	26
3	Skill Based Course	10
4	Engineering Science Course	26
5	Professional Core Courses	51
6	Projects/Internships/ Composite Viva	26
7	Professional Elective	9
8	Open Elective Courses	9
9	Audit Courses	1
	Total	**169**

**Minor variation is allowed as per need of the respective disciplines*

Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BS	Basic Science Courses
ES	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses

Mechanical Course Curriculum

Semester-1	Credits	Semester-2	Credits
1. Mathematics-I **[BS-101]**	3:0:0=3	1. Mathematics-II **[BS-201]**	3:1:0=4
2. Basic Electrical Engineering **[ES-101 (T)]**	2:0:0=2	2. Physics-I **[BS-202 (T)]**	3:1:0=4
		3. Physics-I Lab **[BS-202 (P)]**	0:0:2=1
3. Basic Electrical Engineering **Lab [ES-101 (P)]**	0:0:2=1	4. Chemistry **[BS-203 (T)]**	3:0:0=3
		5. Chemistry Lab **[BS-203 (P)]**	0:0:2=1
4. Engineering Graphics & Design **[ES-102]**	1:0:4=3	6. Programming for Problem Solving **[ES-201 (T)]**	2:0:0=2
5. English for Technical Writing **[HSMC-101 (T)]**	2:0:0=2	7. Programming for Problem Solving Lab **[ES-201 (P)]**	0:0:4=2
6. English for Technical Lab **[HSMC-101 (P)]**	0:0:2=1	8. Digital Fabrication /Workshop/Manufacturing Practices Lab **[ES-202]**	0:0:4=2
7. Biology for Engineers **[BS -102]**	3:0:0=3	9. Design Thinking **[ES-203]**	0:0:2=1
8. Basic Engineering **Workshop [ES-103]**	0:0:4=2	10. Universal Human Value -1 **[HSMC-201]**	2:0:0=2
9. Skill Based Course-1 **[SBC-101]**	1:0:4=3	11. Sports and Yoga/ NSS/NCC **[AU-202]**	2:0:2=0
		12. Skill Based course -II **[SBC-201]**	1:0:4=3
Total Credits	**20**	**Total Credits**	**25**

Semester-3	Credits	Semester-4	Credits
1. Physics-II**(BS-301)**	3:0:0=3	1. Applied Thermodynamics (**PCC-ME-401**)	3:0:0=3
2. Mathematics-III **(BS-302)**	3:0:0=3	2. Fluid Mechanics and Fluid Machines **(PCC-ME-402)**	4:1:0=5
3. Basic Electronics Engineering **(ES-301)**	3:0:0=3	3. Strength of Materials **(PCC-ME-403)**	3:0:0=3
4. Engineering Mechanics **(ES-302)**	3:0:0=3	4. Kinematics of Machines **(PCC-ME-404)**	3:1:0=4
5. Thermodynamics **(PCC-ME-301)**	3:0:0=3	5. Introduction to Ansys (**SBC-401**)	0:0:1=1
6. Shaper Machine Operation and Maintenance **(SBC-301)**	1:0:2=3	6. Fluid & Hydraulics Laboratory **(PCC-ME-405)**	0:0:1=1
7. Indian Knowledge System **(AU-301)**	1:0:0=1	7. Strength of Material Lab (**PCC-ME-406)**	0:0:1=1
8. Physics -II lab **(BS-303)**	0:0:1=1	8. **Environmental Science (BS-401)**	0:0:2=0
9. Engineering Mechanics Lab **(ES-303)**	0:0:1=1	9. **Internship-1 (ME-I-401)**	0:0:3=3
Total Credits	**21**	Total Credits	**21**

Semester–5	Credits	Semester–6	Credits
1. Heat Transfer and Thermal Machines **(PCC-ME-501)**	4:1:0=5	1. Manufacturing Technology **(PCC-ME-601)**	3:0:0=3
2. Instrumentation and control **(ES-501)**	3:0:0=3	2. Industrial Engineering and Management **(PCC-ME-602)**	3:0:0=3
3. Manufacturing Processes **(PCC-ME-502)**	3:0:0=3	3. Operation Research **(PCC-ME-603)**	3:0:0=3
		4. Machine Design **(PCC-ME-604)**	3:1:0=4
		5. Engineering Materials **(PCC-ME-605)**	3:0:0=3
4. Numerical Methods and computation **(PCC-ME-503)**	3:1:0=4	6. Management and accountancy **(HSMC-601)**	3:0:0=3
5. Managerial Economics **(HSMC-501)**	3:0:0=3	7. Heat Transfer Laboratory **(PCC-ME-606)**	0:0:1=1
6. Professional Ethics **(AU-501)**	0:0:2=0		
	0:0:1=1		

7. Dynamics of Machinery Lab **(PCC-ME-504)** 8. Applied thermodynamics Lab (**PCC-ME-505)** 9. Engineering Workshop **(ES-502)** 10. Internship-2**(ME-I-501)**	0:0:1=1 0:0:1=1 0:0:3=3	8. Mini Project **(PROJ-ME-601)**	0:0:3=3
Total Credits	**24**	Total Credits	**23**
Semester–7	Credits	**Semester–8**	Credits
1. ProfessionalElective-1: Refrigeration and Air Conditioning (RAC)(**PEC-MEL-701)** /Eco Friendly Design **(PEC-MEL-702)** 2. ProfessionalElective-2: Computational Fluid Dynamics **(PEC-MEL-703)**/ Design for Manufacturing and Assembly (**PEC-MEL-704)** **3.** OpenElective-1: Renewable energy engineering **(OEC-701)** / Additive Manufacturing Technology (**OEC-702)** 4. OpenElective-2: Power Plant Engineering (**OEC-703)** / Die Mold Tool Design (**OEC-704)** 5. Engineering Project-1**(PROJ-ME-701)** 6. Internship -3 **(ME-I-701)**	3:0:0=3 3:0:0=3 3:0:0=3 0:0:6=6 0:0:3=3	**1.** ProfessionalElective-3: Automobile Engineering (**PEC-MEL-801)** / Nuclear Engineering **(PEC-MEL-802)** **2.** OpenElective-3(Aerospace Engineering (**OEC-801)**/ Marine Engineering **(OEC-802)** 3. EngineeringProject-2 **(PROJ-ME-801)** 4. Composite Viva **(ME-V-801)**	3:0:0=3 3:0:0=3 0:0:6=6 0:0:2=2
Total Credits	**21**	Total Credits	**14**

Humanities and Social Sciences Including Management Courses

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	HSMC-101(T)	English for Technical writing	2	0	0	2	1
2	HSMC-101 (P)	English for Technical writing	0	0	2	1	1
3	HSMC-201	Universal Human Values-I	2	0	0	2	2
4	HSMC-501	Managerial Economics	3	0	0	3	5
5	HSMC-601	Management and Accountancy	3	0	0	3	6
					Total Credits:	**11**	

Basic Science Course [BS]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	BS-101	Mathematics-I	3	0	0	**3**	**1**
2	BS-102	Biology for Engineers	3	0	0	**3**	**1**
3	BS-201	Mathematics-II	3	1	0	**4**	**2**
4	BS-202 (T)	Physics-I	3	1	0	**4**	**2**
5	BS-202 (P)	Physics-I Lab	0	0	2	**1**	**2**
6	BS-203 (T)	Chemistry	3	0	0	**3**	**2**

7	BS-203 (P)	Chemistry Lab	0	0	2	**1**	**2**
8	BS-301	Physics-II	3	0	0	**3**	**3**
9	BS-303	Physics -II Lab	0	0	1	**1**	**3**
10	BS-302	Mathematics-III	3	0	0	**3**	**3**
11	BS-401	Environmental Science	0	0	2	**0**	**4**
					Total Credits:	**26**	

Skill Based Course [SBC]

Sl. No.	**Code No.**	**Course Title**	**Hours Per Week**			**Total Credits**	**Semester**
			Lecture	Tutorial	Practical		
1	SBC-101	Introduction to Automobiles	1	0	4	3	1
2	SBC-201	Computer Aided Designs	1	0	4	3	2
3	SBC-301	Shaper Machine Operation and Maintenance	1	0	2	3	3
4	SBC-401	Introduction to Ansys	0	0	1	1	4
					Total Credits:	**10**	

Engineering Science Course[ES]

Sl. No	**Code No.**	**Course Title**	**Hours per week**			**Total Credits**	**Semester**
			Lecture	Tutorial	Practical		
1	ES-101(T)	Basic Electrical Engineering	2	0	0	2	1
2	ES-101(P)	Basic Electrical Engineering Lab	0	0	2	1	1
3	ES-102	Engineering Graphics & Design	1	0	4	3	1
4	ES-103	Basic Engineering Workshop	0	0	4	2	1
5	ES-201 (T)	Programming for Problem Solving (T)	2	0	0	2	2
6	ES-201 (P)	Programming for Problem Solving Lab	0	0	4	2	2
7	ES-202	Digital Fabrication/ Workshop/Manufacturing Practices	0	0	4	2	2
8	ES-203	Design Thinking	0	0	2	1	2
9	ES-301	Basics Electronics Engineering	3	0	0	3	3
10	ES-302	Engineering Mechanics	3	0	0	3	3
11	ES-303	Engineering Mechanics Lab	0	0	1	1	3
12	ES-501	Instrumentation and control	3	0	0	3	5
13	ES-502	Engineering Workshop	0	0	1	1	5
					Total Credits:	**26**	

Professional Core Courses [PCC]

Sl. No	**Code No.**	**Course Title**	**Hours per week**	**Total Credits**	**Semester**

			Lecture	Tutorial	Practical		
1	PCC-ME-301	Thermodynamics	3	0	0	3	3
2	PCC-ME-401	Applied Thermodynamics	3	0	0	3	4
3	PCC-ME-402	Fluid Mechanics and Fluid Machines	4	1	0	5	4
5	PCC-ME-403	Strength of Materials	3	0	0	3	4
6	PCC-ME-404	Kinematics of Machines	3	1	0	4	4
7	PCC-ME-405	Fluid & Hydraulics Laboratory	0	0	1	1	5
8	PCC-ME-406	Strength of Material Lab	0	0	1	1	4
9	PCC-ME-501	Heat Transfer and Thermal Machines	4	1	0	5	5
10	PCC-ME-502	Manufacturing Processes	3	0	0	3	5
11	PCC-ME-503	Numerical Methods and computation	3	1	0	4	5
12	PCC-ME-504	Dynamics of Machinery Lab	0	0	1	1	5
13	PCC-ME-505	Applied Thermodynamics Lab	0	0	1	1	5
14	PCC-ME-601	Manufacturing Technology	3	0	0	3	6
15	PCC-ME-602	Industrial Engineering and Management	3	0	0	3	6
16	PCC-ME-603	Operation Research	3	0	0	3	6
17	PCC-ME-604	Machine Design	3	1	0	4	6
18	PCC-ME-605	Engineering Materials	3	0	0	3	6
19	PCC-ME-606	Heat Transfer Laboratory	0	0	1	1	6
					Total Credits:	**52**	

Projects/Internships/ Composite Viva

Sl. No.	**Code No.**	**Course Title**	**Hours Per Week**			**Total Credits**	**Semester**
			Lecture	Tutorial	Practical		
1	ME-I-401	Internship-1	0	0	3	3	4
2	ME-I-501	Internship-2	0	0	3	3	5
	PROJ-ME-601	Mini Project	0	0	3	3	6
3	ME-I-701	Internship-3	0	0	3	3	7
4	PROJ-ME-701	Engineering Project-1	0	0	6	6	7
4	PROJ-ME-801	Engineering Project-2	0	0	6	4	8
6	ME-V-801	Composite Viva	0	0	2	2	8
					Total Credits:	**24**	

Professional Elective [PEC]

Sl. No	**Code No.**	**Course Title**	**Hours per week**	**Total Credits**	**Semester**

			Lecture	Tutorial	Practical		
1	PEC-MEL-701/ PEC-MEL-702	Professional Elective- 1 (Refrigeration and Air Conditioning (RAC)/Eco Friendly Design)	3	0	0	3	7
2	PEC-MEL-703/ PEC-MEL-704	Professional Elective- 2 (Computational Fluid Dynamics/Design for Manufacturing and Assembly)	3	0	0	3	7
3	PEC-MEL-801/ PEC-MEL-802	Professional Elective- 3 (Automobile engineering/ Nuclear Engineering)	3	0	0	3	8
Total Credits						**11**	

Open Elective Courses [OEC]

Sl.No	**Code No.**	**Course Title**	**Hours per week**			**Total Credits**	**Semester**
			Lecture	Tutorial	Practical		
1	OEC-701/ OEC-702	Open Elective–1 (Renewable Energy Engineering/ Additive Manufacturing Technology)	3	0	0	3	7
2	OEC-703/ OEC-704	Open-Elective-2 (Power Plant Engineering/ Die Mold Tool Design)	3	0	0	3	7
3	OEC-801/ OEC-802	Open-Elective-3 (Aerospace Engineering/ Marine Engineering)	3	0	0	3	8
Total Credits:						**9**	

Audit Courses [AU]

Sl. No	**Code No.**	**Course Title**	**Hours per week**			**Total Credits**	**Semester**
			Lecture	Tutorial	Practical		
1	AU-202	Sports Yoga or NSS/ NCC	2	0	2	0	2
2	AU-301	Indian Knowledge System	1	0	1	1	3
3	AU-501	Professional Ethics	0	0	2	0	5
Total Credits:						**1**	

Total Credits=169

Minor Degree Course in Additive Manufacturing

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	PCC-MEM-501	Fundamentals of Additive Manufacturing	3	0	0	3	5
2	PCC-MEM-601	Product Design and Prototyping	3	0	0	3	6
3	PCC-MEM-701	Advanced Physical and Mechanical Metallurgy	3	0	0	3	7
4	PCC-MEM-702	Additive Manufacturing Processes Lab	0	0	4	2	7
5	PCC-MEM-EL-801/802	Elective-I (Finite Element Method/ Machine Learning applications)	3	1	0	4	8
6	PCC-MEM-EL-803/804	Elective-II (3D printing/ Industry 4.0)	3	0	0	3	8
Total Credits:						**18**	

1st Semester

Course Code	Course Name	L-T-P-Credits
SBC-101	Introduction to Automobiles	1-0-4-3

Contents:

Introduction to Automobiles: Introduction to Automobile Industry and History, Vehicle Architecture and Classification, Automotive Safety Regulations and Standards

Introduction to conventional automobiles with IC Engines: Basics of Thermodynamics and Combustion, Automotive Transmission Systems, Braking Systems, Suspension and Steering Systems, Vehicle Electrical and Electronics Systems, Automotive HVAC Systems, Automotive Safety Systems and Advanced Driver Assistance Systems (ADAS)

Alternative Propulsion Systems: Introduction to Electric Vehicles (EVs), Hybrid Electric Vehicles (HEVs), Fuel Cell Vehicles (FCVs)

Practical Exposure and Skill Development: Vehicle Inspection and Maintenance, Design of an Electric or Fuel Cell Vehicle Component/System.

Text/Reference Books:

1. Heywood, J. B. (1988). Internal Combustion Engine Fundamentals (1st ed.). McGraw-Hill.
2. Husain, I. (2014). Electric and Hybrid Vehicles: Design Fundamentals (1st ed.). CRC Press.
3. Jurgen, R. K. (1994). Automotive Electronics Handbook (1st ed.). McGraw-Hill.
4. Gilles, T. (2019). Automotive Service: Inspection, Maintenance, Repair (6th ed.). Cengage Learning.

2nd Semester

Course Code	Course Name	L-T-P-Credits
SBC-201	**Computer Aided Designs**	**1-0-4-3**

Contents:

Overview of Computer Graphics: Listing the computer technologies that impact on graphical communication, demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects; Isometric Views of lines, Planes, Simple and compound Solids];

Customization & CAD Drawing: Consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Annotations, layering & other functions: Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modelling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching
of perspective, isometric, multi view, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerance techniques; dimensioning and scale multi views of dwelling;

Demonstration of a simple team design project: Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modelling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Text/Reference Books:

1. Shah, M. B., & Rana, B. C. (2008). Engineering Drawing and Computer Graphics (1st ed.). Pearson Education.
2. Jolhe, D. A. (2017). Engineering Drawing: With an Introduction to AutoCAD (1st ed.). Tata McGraw Hill.

3rd Semester

Course Code	Course Name	L-T-P-Credits
BS-301	**Physics II**	**3-0-0-3**

Contents:

Simple harmonic motion, damped and forced simple harmonic oscillator**:** Mechanical and electrical simple harmonic oscillators, complex number notation and phasor representation of simple harmonic motion, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator.

Non-dispersive transverse and longitudinal waves in one dimension and introduction to dispersion**:** Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves and speed of sound, standing sound waves. Waves with dispersion, water waves, superposition of waves, wave groups and group velocity.

The propagation of light and geometric optics: Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Critical angle, total internal reflection.

Wave optics: Huygen's principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer. Fraunhofer diffraction from a single slit and a double slit, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power. Polarization of light, plane of vibration and plane of polarization, Brewster's law, Malus law, Double refraction, Nicol Prism, Quarter wave plate and half wave plate, Production and detection of circularly and elliptically polarized light, Induced birefringence- Kerr Cell, Polaroid and applications.

Lasers and Fibre Optics: Absorption, spontaneous and stimulated emissions, population inversion, Einstein's coefficients, working principles of laser, Optical resonant cavity, different types of lasers: gas lasers (He-Ne, CO_2), solid-state Lasers (ruby, Semiconductor), dye lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in science, engineering and medicine, fibre optics: Principle of propagation and loss in optical fibre cable, types of optical fibres, numerical aperture, optical communication system (Block diagram), industrial, medical and technological applications of optical fibre.

Text/Reference Books:

1. AICTE. (2019). Physics (Oscillations, Waves & Optics) with Lab Manual. [Lab manual]. ISBN: 978-93-91505-13-4.
2. Bhattacharya, P., & Nag, P. K. (2014). Engineering Physics. Oxford University Press.
3. Main, I. G. (2013). Oscillations and waves in physics. Cambridge University Press.
4. Pain, H. J. (2005). The physics of vibrations and waves. John Wiley & Sons.
5. Hecht, E. (2017). Optics. Pearson.
6. Ghatak, A. K. (2015). Optics. Tata McGraw-Hill Education.
7. Svelto, O. (2010). Principles of Lasers. Springer.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Waves and Oscillations	Prof. M. S. Santhanam	IISER Pune

Course Code	Course Name	L-T-P-Credits
BSC-302	Mathematics III	3-0-0-3

Contents:

Partial Differential Equations: Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method. Second-order linear equations and their classification, Initial and boundary conditions, D'A lembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variables.

Basics of Probability: Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

Basic Statistics: Measures of Central tendency: Moments, skewness and Kurtosis- Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi- square test for goodness of fit and independence of attributes.

Text/Reference Books:

1. Grewal, B. S. (2010). Higher engineering mathematics (36th ed.). Khanna Publishers.
2. Dass, H. K. (2014). Advanced engineering mathematics (Reprint). S Chand and Company Pvt. Ltd.
3. Raisinghania, M. D. (n.d.). Advanced differential equations. S Chand and Company Pvt. Ltd.
4. Thomas, G. B., & Finney, R. L. (2002). Calculus and analytic geometry (9th ed.). Pearson.
5. Kreyszig, E. (2006). Advanced engineering mathematics (9th ed.). John Wiley & Sons.
6. Boyce, W. E., &DiPrima, R. C. (2009). Elementary differential equations and boundary value problems (9th ed.). Wiley India.
7. Ross, S. L. (1984). Differential equations (3rd ed.). Wiley India.

Course Code	Course Name	L-T-P-Credits
ES-301	**Basics Electronics Engineering**	**3-0-0-3**

Contents:

Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

Operational amplifier and its applications: Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.

Timing Circuits and Oscillators: RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.

Digital Electronics Fundamentals : Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, demultiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.

Text /Reference Books:

1. Floyd. (2012). Electronic Devices (9th ed.). Pearson Education.
2. Jain, R. P. (2007). Modern Digital Electronics (3rd ed.). Tata Mc Graw Hill.
3. Frenzel. (2001). Communication Electronics: Principles and Applications (3rd ed.). Tata Mc Graw Hill.

Course Code	Course Name	L-T-P-Credits
ES-302	Engineering Mechanics	3-0-0-3

Contents:

Introduction to Engineering Mechanics covering: Force Systems, Basic concepts, System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams.
Friction covering: Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction.

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; Zero force members; Beams & types of beams; Frames & Machines;

Centroid and Centre of Gravity covering: Centroid of simple figures, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia, Theorems of moment of inertia, Moment of inertia of standard sections .

Review of particle dynamics: Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). curvilinear motion; Work-kinetic energy, power, potential energy.Impulse-momentum (linear, angular).

Introduction to Kinetics of Rigid Bodies: Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies.

Text/Reference Books:

1. Shames, H. (2006). Engineering Mechanics (4th ed.). Prentice Hall.
2. Beer, F. P., & Johnston, E. R. (2011). Vector Mechanics for Engineers, Vol I - Statics, Vol II - Dynamics (9th ed.). Tata McGraw Hill.
3. Hibbler, R. C. (2006). Engineering Mechanics: Principles of Statics and Dynamics. Pearson Press.
4. Ruina, A., & Pratap, R. (2011). Introduction to Statics and Dynamics. Oxford University Press.
5. Shanes, H., & Rao. (2006). Engineering Mechanics. Pearson Education.
6. Hibler, R. C., & Gupta. (2010). Engineering Mechanics (Statics, Dynamics). Pearson Education.
7. Reddy, V. K., & Kumar, K. S. (2010). Singer's Engineering Mechanics.

Course Code	Course Name	L-T-P-Credits
PCC-ME-301	Thermodynamics	3-0-0-3

Contents:

Fundamentals - 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.

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.

First Law for Flow Processes - 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.

Second law - 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.

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; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in T-s 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.

Text/Reference Books:

1. Sonntag, R. E., Borgnakke, C., &VanWylen, G. J. (2003). Fundamentals of Thermodynamics (6th ed.). John Wiley and Sons.
2. Jones, J. B., & Duggan, R. E. (1996). Engineering Thermodynamics. Prentice-Hall of India.
3. Moran, M. J., & Shapiro, H. N. (1999). Fundamentals of Engineering Thermodynamics. John Wiley and Sons.

Course Code	Course Name	L-T-P-Credits
SBC-301	**Shaper Machine Operation and Maintenance**	**1-0-2-3**

Contents:

Introduction to Shaper Machines: Overview of shaper machines, Types of shaper machines, Parts of a shaper machine, Safety precautions when working with a shaper machine Shaper Machine Operations: Setting up the shaper machine, Cutting tools and their usage, Workpiece holding techniques, Cutting operations, Finishing operations, Quality control techniques Maintenance and Repair of Shaper Machines: Maintenance schedules, Lubrication and cleaning, Troubleshooting common problems, Repair and replacement of parts Safety and Environmental Issues: Safety rules and regulations, Proper disposal of waste materials, Hazards associated with shaper machines, Fire prevention and control Practical Training and Projects: Hands-on training on shaper machines or Individual and group projects.

Text/Reference Books:

1. Roberts, G. (2005). Shaper Handbook (1st ed.). Industrial Press.
2. Dhar, J. K. (2017). Principles of Shaper Machines (1st ed.). S. Chand Publishing.
3. Kibbe, R., Neely, J., & Meyer, R. (2000). Machine Tool Practices (10th ed.). Prentice Hall.
4. Raghavan, V. (2014). Shaper, Planer and Slotter Machines (2nd ed.). Tata McGraw Hill.

Course Code	Course Name	L-T-P-Credits
AU-301	**Indian Knowledge System**	**1-0-0-1**

Contents:

Introduction to Indian Knowledge Systems: Historical context and evolution of Indian knowledge systems, Conceptual foundations of Indian knowledge systems, Classification of Indian knowledge systems
Vedic Knowledge System: Overview of Vedas and their significance, Vedic philosophy and worldview, Contributions of Vedic knowledge system in science and mathematics
Contemporary Perspectives on Indian Knowledge Systems: Relevance of Indian knowledge systems in contemporary times, Applications of Indian knowledge systems in solving global challenges, Critique of Indian knowledge systems

Text/Reference Books:

1. Ananda krishnan, M., & Arunachalam, G. (2006). India's contribution to science and technology. Current Science, 91(7), 904-905.
2. Balasubramaniam, R. (2003). Knowledge systems in ancient India. Journal of Indian Philosophy, 31(5-6), 517-534.
3. Chatterjee, A. K. (1998). Indian knowledge systems in the contemporary context. International Journal of Ethics, 108(4), 663-679.

Course Code	Course Name	L-T-P-Credits
ES-303	Engineering Mechanics Lab	0-0-1-1

Contents:

Gravesend's apparatus, Centre of gravity, Friction slide apparatus, Simple pendulum, Simply supported beam, Compound lever, Screw jack, Inclined Plane Apparatus

Text/Reference Books:

1. Shames, H. (2006). Engineering Mechanics (4th ed.). Prentice Hall.
2. Beer, F. P., & Johnston, E. R. (2011). Vector Mechanics for Engineers, Vol I - Statics, Vol II - Dynamics (9th ed.). Tata McGraw Hill.
3. Hibbler, R. C. (2006). Engineering Mechanics: Principles of Statics and Dynamics. Pearson Press.

Course Code	Course Name	L-T-P-Credits
BS-303	Physics- 2 Lab	0-0-1-1

Contents:

1. To determine the acceleration due to gravity using bar pendulum
2. To compare the frequencies of oscillation produced by two audio oscillators using Lissajous figures
3. To determine frequency in transverse and longitudinal vibration using Meldes string apparatus
4. To study forced and damped harmonic oscillations using LCR circuit
5. To determine the velocity of sound in moist air by resonance air column method
6. To determine wavelength of monochromatic source of light using Newton's rings method
7. To determine refractive index of a liquid using Newton's rings method
8. To determine wavelength of He-Ne laser or any standard laser using diffraction grating
9. To determine dispersive power and resolving power of a plane transmission grating
10. To measure the light intensity of plane polarised light as a function of analyser position (Verification of Malus law)

Experiments That May Be Performed Through Virtual Labs:

1. Diffraction and interference experiments(from ordinary light or laser pointers) (http://ovau.vlabs.ac.in/optics/Diffraction_Grating/)
2. Minimum deviation from a prism. (http://ovau.vlabs.ac.in/optics/Spectrometer_i_d_Curve/)
3. Resonance phenomena in LCR circuits (http://vlab.amrita.edu/?sub=1&brc)

Text/Reference Books:

1. Main, I. G. (1988). Oscillations and waves in physics.
2. Pain, H. J. (2005). The physics of vibrations and waves. John Wiley & Sons.
3. Pain, H. J., & Rankin, P. (2012). Introduction to Vibrations and Waves. Oxford University Press.
4. Pain, H. J. (2013). The Physics of Vibrations and Waves. 6th edition. Wiley.
5. Halliday, D., Resnick, R., & Walker, J. (2014). Fundamentals of Physics Extended. 10th edition. John Wiley & Sons, Inc.

4th Semester

Course Code	Course Name	L-T-P-Credits
PCC-ME-401	**Applied Thermodynamics**	**3-0-0-3**

Contents:

IC Engines – SI, CI, two- and four-stroke engines, MEP, efficiency and specific fuel consumption, conventional and alternative fuels, pressure-crank angle diagram, carburettor and fuel injection systems; S.I. and C.I. engine fuels, self-ignition, octane number, cetane number.

Steam Power Plant – Reheat, regenerative steam power cycles, low temperature power cycles, ideal working fluid and binary/multi-fluid cycles; Types of boilers and their attachments.

Steam Turbines – Impulse and reaction turbines, analysis using velocity triangles, Properties of moist air: psychrometry and psychrometric charts, condensers and cooling towers.

Heat Pump and Refrigeration Cycles – reversed Carnot cycle and performance criteria, vapour compression and vapour absorption refrigerators, gas cycles, refrigerants.

Gas Turbine Engines – single and twin shaft arrangements, intercooling, reheating, regeneration, closed cycles, combined cycles, introduction to jet propulsion.

Turbomachinery Aerodynamics –Introduction to centrifugal compressor, axial flow compressors, axial flow turbines, impulse and reaction stages, degree of reaction.

Reciprocating compressors– staging of reciprocating compressors, optimal stage pressure ratio, effect of inter cooling, minimum work for multistage reciprocating compressors.

Direct Energy Conversion– thermionic and thermoelectric converters, photovoltaic generators, MHD generators, fuel cells.

Text/Reference Books:

1. G. F. C. Rogers and Y. R. Mayhew**,** (2001).Engineering Thermodynamics, *Pearson.*
2. T. D. Eastop and A. McConkey, (1999). *A*pplied Thermodynamics for Engineering Technologists, Pearson.
3. W. W. Pulkrabek, (2002).Engineering Fundamentals of the Internal Combustion Engine, *PHI.*
4. Nag, P. K. (1995). Engineering Thermodynamics. TMH.

Course Code	Course Name	L-T-P-Credits
PCC-ME-402	**Fluid Mechanics and Fluid Machines**	**4-1-0-5**

Contents:

Introduction - Basic ideas of continuum, fluid properties including viscosity, surface tension and vapour pressure.

Fluid Statics**:** Hydrostatic pressure distribution, Manometry, Forces on submerged bodies, Buoyancy and Floatation, Stability of floating bodies, Pressure distribution in rigid body motion,

Fluid kinematics - Lagrangian and Eulerian descriptions, Deformation of fluid element, Strain rates, Vorticity, Flow description using pathline, streamline and streak line.

Conservation laws: Reynolds Transport Theorem, Integral form of conservation laws – mass, linear momentum, angular momentum and energy, Differential form of conservation laws, Elementary derivation of Navier-Stokes equations, Exact solution to Navier-Stokes equations: Couette flow and Poiseulle flow.

Inviscid flows - Bernoulli equation and applications, overview of various losses.

Plane potential flows – Streamfunction, velocity potential, superposition, source, sink, Doublet, Rankine half body, flow past a cylinder, circulation, D'Alembert's Paradox.

Dimensional analysis: Buckingham Pi theorem, dimensionless groups, similitude laws and scaling.

Viscous flows - Demonstration of simple analytical approach, channel flow, entrance length, fully-developed flow, friction factor and head losses, Darcy-Weisbach equation, basic introduction to turbulent flows, Boundary Layer Theory; Derivation of Boundary Layer equation, Displacement, Momentum and Energy thickness, Karman momentum-integral equation.

Compressible flow– Regimes of compressible flow, Definition of Mach number and speed of sound, Adiabatic and isentropic steady flow, Governing equations for 1–D inviscid flows, Isentropic flow with area change, convergent, divergent and convergent-divergent nozzles, Choked flow, Rankine-Huginiot relations and introduction to shocks.

Hydraulic Machines – Euler pump/turbine equation, classification of hydraulic machines, Impulse momentum principle, velocity triangles, efficiency, Centrifugal and Axial pumps, velocity triangles and analysis, effect of blade angle, cavitation, NPSH, specific speed, characteristic curves, series and parallel operations, Pelton turbines: working principle, velocity triangles, performance characteristics, effect of number of buckets and multi-jets, efficiency, Reaction turbines:, Francis and Kaplan turbines, velocity triangles and analysis, draft tube, specific speed, efficiency,

Positive displacement pumps - Working principle, indicator diagram, efficiencies, effect of air vessel, slip and characteristic curves.

Texts and References:

1. F. M. White, F. M. (2008). Fluid Mechanics, Tata McGraw-Hill.
2. R. W. Fox, R. W., McDonald, A. T. and Pritchard, P. J., (2004). Introduction to Fluid Mechanics, John Wiley.
3. Cengel Y. A., and Cimbala, J. M., (2006), Fluid Mechanics, Tata McGraw Hill.
4. Munson, B. R., Young, D. F., and Okhiishi, T. H., (2002). Fundamentals of Fluid Mechanics, John Wiley.
5. Potter, M. C., Wiggert, D. C., and Ramadan, B. H., (2012). Mechanics of Fluids, Cengage.
6. Douglas, J. F., Gasiorek, J. M., Swaffield, J. A. and Jack, L. B. (2008). Fluid Mechanics, Pearson.

Course Code	Course Name	L-T-P-Credits
PCC-ME-403	**Strength of Materials**	**3-0-0-3**

Contents:

Deformation in solids- Hooke's law, Poisson's ratio; stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle for plane stress and plane strain. Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes

Beams and types transverse loading on beams- shear force and bend moment diagrams-Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.
Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure, significance of stress-strain in design of pressure vessel. Testing of materials with universal testing machine; testing of hardness and impact strength.

Text/Reference Books:

1. Popov, E. P. (2001). Engineering Mechanics of Solids (1st ed.). Prentice Hall of India.
2. Subramanian, R. (2007). Strength of Materials (1st ed.). Oxford University Press.
3. Beer, F. P., Johnson Jr, R., & Dewole, J. J. (2005). Mechanics of Materials (1st ed.). Tata McGraw Hill Publishing Co. Ltd.

Course Code	Course Name	L-T-P-Credits
PCC-ME-404	Kinematics of Machines	3-1-0-4

Contents:

Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- 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 mechanism, straight line generators- Universal Joint- Rocker mechanisms.

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics-.

Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation.

Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics, gear box of centrifugal compressor and pumps, Selection of different types of gears and load calculation.

Gyroscopic Couple, Fly wheel, Governor

Text/Reference Books:

1. Bevan, T. (2005). Theory of Machines (3rd ed.). CBS Publishers & Distributors.
2. Cleghorn, W. L. (2005). Mechanisms of Machines (1st ed.). Oxford University Press.
3. Norton, R. L. (2009). Kinematics and Dynamics of Machinery (1st ed.). Tata McGrawHill.
4. Ghosh, A., & Mallick, A. K. (1988). Theory of Mechanisms and Machines (1st ed.). Affiliated East-West Pvt. Ltd.

Course Code	Course Name	L-T-P-Credits
SBC-401	Introduction to Ansys	0-0-1-1

Contents

Introduction to Ansys: Introduction to finite element analysis (FEA), Overview of Ansys software suite.
Ansys GUI: Understanding the Ansys graphical user interface (GUI), Basic modeling techniques and file management.
Ansys Workbench: Overview of Ansys Workbench, Creating and modifying geometry, Creating and editing mesh, Analysis setup and solving, Results interpretation and post-processing, Hands-on exercises using Workbench.
Ansys Mechanical: Introduction to Ansys Mechanical, static structural analysis, Modal and harmonic analysis, Thermal analysis E. Fatigue analysis.

Text/Reference Books:

1. Shih, R. H. (2022). Introduction to Finite Element Analysis Using SolidWorks Simulation (2nd ed.). SDC Publications.
2. Nakasone, Y., & Yoshimoto, S. (n.d.). Engineering Analysis with ANSYS Software (1st ed.). Elsevier.
3. Lawrence, K. L. (2013). Ansys Workbench Tutorial (1st ed.). SDC Publications.
4. Thompson, M. K., & Martin, J. (2017). Ansys Mechanical APDL for Finite Element Analysis (1st ed.). Academic Press.
5. Ansys Inc. (n.d.). Ansys Fluent Theory Guide (1st ed.). Ansys Inc.

Course Code	Course Name	L-T-P-Credits
PCC-ME-405	Fluid & Hydraulics Laboratory	0-0-1-1

Contents

Discharge over notches, Reynolds apparatus,Bernoulli's theorem apparatus,Losses due to pipe fittings, Losses due to pipe friction, Laminar Flow Table, Impact of jet on vanes, Orifice meter and venturi meter test rig, Pitot tube, Cavitation Apparatus, Kaplan turbine test rig, Francis turbine test rig, Pelton wheel turbine test rig, Gear pump test rig, Centrifugal pump test rig, Reciprocating pump test rig, Submersible pump test rig, Jet pump test rig, Wind tunnel test rig.

Text/Reference Books:

1. Som, S. (2011). Introduction to Fluid Mechanics and Fluid Machines (1st ed.). McGraw Hill Education India.
2. Bansal, R. K. (2005). A Textbook of Fluid Mechanics and Hydraulic Machines (1st ed.). Laxmi Publications.

Course Code	Course Name	L-T-P-Credits
PCC-ME-406	**Strength of Material Lab**	**0-0-1-1**

Contents:

Universal testing machine, Brinell hardness tester, Rockwell hardness tester, Vickers hardness tester, Impact testing machine, Torsion testing machine

Text/Reference Books:

1. Popov, E. P. (2001). Engineering Mechanics of Solids (1st ed.). Prentice Hall of India.
2. Subramanian, R. (2007). Strength of Materials (1st ed.). Oxford University Press.
3. Beer, F. P., Johnson Jr, R., &Dewole, J. J. (2005). Mechanics of Materials (1st ed.). Tata McGraw Hill Publishing Co. Ltd.

Course Code	Course Name	L-T-P-Credits
BS-401	**Environmental Science**	**0-0-2-0**

Contents:

Environmental Science syllabus is common to all branches of study.

Course Code	Course Name	L-T-P-Credits
ME-I-401	**Internship-1**	**0-0-3-3**

Contents

Internship: Gain practical experience in an organization for skill development, report preparation, presentation, and certification. Submission of report at department, presentation or viva for evaluation.

5th semester

Course Code	Course Name	L-T-P-Credits
PCC-ME-501	Heat Transfer and Thermal Machines	4-1-0-5

Contents:

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.

Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural 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.

Interaction of radiation with materials, definitions of radiative properties, Wien's displacement law, 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, radiation network analysis.

Types of heatexchangers, Analysis and design of heat exchangers using both LMTD and ε-NTU methods, TEMA specification for heat exchanger. Different problem faced on leakages in heat exchanger.
Boiling and Condensation heat transfer, Pool boiling curve

Introduction mass transfer, Similarity between heat and mass transfer

Text/Reference Books:

1. Bejan, A. (1993). Heat Transfer (1st ed.). John Wiley.
2. Holman, J. P. (1997). Heat Transfer (8th ed.). McGraw Hill.
3. Incropera, F. P., & Dewitt, D. P. (2007). Fundamentals of Heat and Mass Transfer (6th ed.). John Wiley.
4. Kaviany, M. (2002). Principles of Heat Transfer (1st ed.). John Wiley.
5. Cengel, Y. A. (2002). Heat Transfer: A Practical Approach (1st ed.). McGraw Hill.

Course Code	Course Name	L-T-P-Credits
ES-501	Instrumentation and Control	3-0-0-3

Contents:

Measurement systems and performance – accuracy, range, resolution, error sources; Instrumentation system elements – sensors for common engineering measurements; Signal processing and conditioning; correction elements- actuators: pneumatic, hydraulic, electric; Control systems – basic elements, open/closed loop, design of block diagram; control method

– P, PI, PID, when to choose what, tuning of controllers; System models, transfer function and system response, frequency response; Nyquist diagrams and their use.
Practical group-based project utilizing above concepts.

Text/Reference Books:

1. Bolton, W. (2000). Instrumentation and Control Systems (2nd ed.). Newnes.
2. Beckwith, T. G., Marangoni, R. D., & Lienhard, J. H. V. (2007). Mechanical Measurements (6th ed.). Pearson Education India.
3. McMillan, G. K. (1999). Process/Industrial Instruments and Controls Handbook (5th ed.). McGraw-Hill.

Course Code	Course Name	L-T-P-Credits
PCC-ME-502	Manufacturing Processes	3-0-0-3

Contents:

Conventional Manufacturing processes**:** Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

Introduction of Additive manufacturing: Rapid prototyping and rapid tooling

Introduction to bulk and sheet metal forming, fundamentals of hot and cold working processes; load estimation for bulk forming (forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling, Introduction to CNC machining.

Joining/fastening processes: Physics of welding, Selection of welding process, uses of different welding electrodes and filler as per AWS for different parent materials. brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding. Fabrication machinery: Selection and uses.

Unconventional Machining Processes: Abrasive Jet Machining, Water Jet Machining,

Abrasive Water Jet Machining, Ultrasonic Machining, Electrical Discharge Machining, wire EDM, Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining,

Electro-chemical machining, principle, MRR, surface finish, process capabilities, process parameters.

Text/Reference Books:

1. Kalpakjian, S., & Schmid, S. R. (2014). Manufacturing Processes for Engineering Materials (5th ed.). Pearson India.
2. Groover, M. P. (2010). Fundamentals of Modern Manufacturing: Materials, Processes, and Systems (4th ed.). John Wiley & Sons.
3. DeGarmo, E. P., Black, J. T., & Kohser, R. A. (2003). Materials and Processes in Manufacturing (9th ed.). Wiley.
4. Rao, P. N. (2004). Manufacturing Technology (Vol. I & II) (3rd ed.). Tata McGraw-Hill.

Course Code	Course Name	L-T-P-Credits
PCC-ME-503	**Numerical Methods and Computation**	**3-1-0-4**

Contents:

Solution Of Equations and Eigen Value Problems: Iterative method, Newton-Raphson method for single variable and for simultaneous equations with two variables. Solutions of a linear system by Gaussian, Gauss-Jordan, Jacobi and Gauss-Seidel methods. Inverse of a matrix by Gauss-Jordan method. Eigen value of a matrix by Power and Jacobi Methods.

Interpolation: Newton's divided difference formulae, Lagrange's polynomials, Newton forward and backward difference formulae, Stirling's and Bessel's Central difference formulae.

Numerical Differentiation and Integration: Numerical differentiation with interpolation polynomials, Numerical integration by Trapezoidal and Simpson's (both 1/3 rd and 3/8 th) rules. Two- and Three-point Gaussian quadrature formula. Double integrals using Trapezoidal and Simpson's rule.

Initial Value Problems for Ordinary Differential Equations: Single Step Methods - Taylor Series, Euler and Modified Euler, Runge-Kutta method of order four for first and second order differential equations.

Text/Reference Books:

1. Veera Rajan, T., & Rama Chandran, T. (2008). Numerical Method (1st ed.). Tata McGraw Hill.
2. Chapra, C. (1988). Numerical Methods for Engineers (2nd revised ed.). Tata McGraw Hill.
3. Balaguruswamy, E. (2017). Numerical Methods (4th ed.). Tata McGraw Hill.
4. Sastry, S. S. (2012). Introductory Methods of Numerical Analysis (5th ed.). Prentice Hall of India.

Course Code	Course Name	L-T-P-Credits
HSMC-501	**Managerial Economics**	**3-0-0-3**

Contents:

Nature, scope and methods of managerial economics.
Managerial Economic Concepts – Incremental concept; Opportunity Cost concept; Equi-marginal concept; discounting concept; Risk & Uncertainty.

Law of Diminishing Marginal Utility.

Demand Analysis – Meaning & type; Law of Demand – features; Exceptions; Market Demand Schedule & Curve; Elasticity of Demand – Price elasticity, cross elasticity& income elasticity.

Indifference Curve approach and its properties. Supply – its law, elasticity & curve.
Types of markets; Pricing under various market conditions – Perfect competition, imperfect competition & monopolistic competition.
Profit &Profit measurement.

Inflation – meaning; Demand-pull, cost-push inflation; Inflationary gap; Causes and steps to control inflation.

National Income – Concepts & methods of measurement; Difficulties in measuring national income.

Text/Reference Books:

1. Samuelson, W. F., & Marks, S. G. (2012). Managerial Economics (1st ed.). John Wiley & Sons, Inc.
2. Allen, W. B., Weigelt, K., Doherty, N., & Mansfield, E. (2012). Managerial Economics: Theory, Applications, and Cases (8th ed.). W. W. Norton & Company.
3. Thomas, C., & Maurice, S. C. (2010). Managerial Economics (10th ed.). McGraw-Hill Education.

Course Code	Course Name	L-T-P-Credits
AU-501	Professional Ethics	0-0-2-0

Contents:

Introduction to Professional Ethics: Definition and importance of professional ethics, Historical and philosophical overview of ethics, Ethical theories and frameworks, Moral reasoning and ethical decision-making
Ethical Issues in Engineering: Ethics and safety in engineering, Ethics and the environment, Ethics and intellectual property, Ethics and emerging technologies (e.g., AI, robotics)
Professionalism in Engineering: Professional responsibilities and obligations of engineers, Codes of ethics and professional conduct, Engineering as a profession, Ethical leadership in engineering

Text Books & references:

1. Harris, C. E., Pritchard, M. S., &Rabins, M. J. (2009). Engineering Ethics: Concepts and Cases (2nd ed.). Cengage Learning.
2. Suresh, J., & Adhikari, S. (2018). Professional Ethics and Human Values (1st ed.). Oxford University Press.
3. Venkatasubramanian, K. N. (2012). Ethics for Engineers (1st ed.). Prentice-Hall of India Pvt. Ltd.
4. Deigh, J. (2010). An Introduction to Ethics (1st ed.). Cambridge University Press.

Course Code	Course Name	L-T-P-Credits
PCC-ME-504	Dynamics of Machinery Lab	0-0-1-1

Contents:

Gyroscope, Cam analysis apparatus, Universal governor apparatus, Static and dynamic balancing,Rope brake dynamometer , Epicyclic gear train, Universal vibration apparatus ,Whirling of shaft, Journal bearing apparatus, Combined coil and belt friction apparatus, Jib crane apparatus, Coriollis component of acceleration, Centrifugal force apparatus

Text/Reference Books:

1. Bevan, T. (2005). Theory of Machines (3rd ed.). CBS Publishers & Distributors.
2. Cleghorn, W. L. (2005). Mechanisms of Machines (1st ed.). Oxford University Press.
3. Norton, R. L. (2009). Kinematics and Dynamics of Machinery (1st ed.). Tata McGrawHill.
4. Ghosh, A., & Mallick, A. K. (1988). Theory of Mechanisms and Machines (1st ed.). Affiliated East-West Pvt. Ltd, New Delhi.

Course Code	Course Name	L-T-P-Credits
PCC-ME-505	Applied Thermodynamics Lab	0-0-1-1

Contents:

Single cylinder four stroke diesel engine, Single cylinder four stroke petrol engine,Single cylinder two stroke petrol engine,Multi cylinder four stroke diesel engine, Multi cylinder four stroke petrol engine,Variable compression ratio diesel engine ,Automotive multi fuel research engine ,Exhaust Gas Analyser, Single stage air compressor,Double stage air compressor, Separating and throttling calorimeter

Text/Reference Books:

1. Sonntag, R. E., Borgnakke, C., & Van Wylen, G. J. (2003). Fundamentals of Thermodynamics (6th ed.). John Wiley and Sons.
2. Jones, J. B., & Duggan, R. E. (1996). Engineering Thermodynamics (1st ed.). Prentice-Hall of India.
3. Moran, M. J., & Shapiro, H. N. (1999). Fundamentals of Engineering Thermodynamics (4th ed.). John Wiley and Sons.
4. Nag, P. K. (1995). Engineering Thermodynamics (1st ed.). Tata McGraw-Hill Publishing Co. Ltd.
5. Saravanamuttoo, H. I. H., Rogers, G. F. C., & Cohen, H. (2003). Gas Turbine Theory (4th ed.). Pearson.

Course Code	Course Name	L-T-P-Credits
ES-502	Engineering Workshop	0-0-1-1

Contents:

Experiment on shaping machine: flat surfaces, dovetail cutting – grooving, keyway cutting etc..
Experiment on slotting machine: flat surfaces, dovetail cutting – grooving, keyway cutting etc. - making hexagonal hole using slotting machine.
Study of milling machines – nomenclature of milling cutters – different types of milling cutters – attachments for milling: vertical milling and universal milling attachment, high speed milling attachment, rack milling and slot attachments, parking bracket, rotary table, universal dividing head, vices, arbors, adaptors and collet chucks. Experiment on milling machine1: plane milling, keyway cutting, cutting of splines. Experiment on milling machine2 :cutting of spur, helical and bevel gears – study of different methods of indexing - multi slot cutting on milling machine by indexing.
Study of surface grinding machine and demonstration of grinding of plane surface - study of cylindrical grinding machine and demonstration of plane cylindrical grinding – study and demonstration of planning machine – study and demonstration of broaching machine. Plasma Cutting Operations.
Study of the working principle: Practical cutting operations with different thickness of metal plates and experiments.
Study of Plasma Cutting on different alloys Practices.

Experimental work with CNC Machines.

Text/Reference Books:

1. Hazra Choudhury, S. K., Hazra Choudhury, A. K., & Roy, N. Elements of Workshop Technology (Vol. I & II).
2. Rajput, R. K. A Textbook of Manufacturing Technology.

Course Code	Course Name	L-T-P-Credits
ME-I-501	**Internship-2**	**0-0-3-3**

Contents:

Internship: Gain practical experience in an organization for skill development, report preparation, presentation, and certification. Submission of report at department, presentation or viva for evaluation.

6th Semester

Course Code	Course Name	L-T-P-Credits
PCC-ME-601	Manufacturing Technology	3-0-0-3

Contents:

Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometers; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and work piece quality.

Shaper, planner &slotter, machines - Classification - principles of working components, work holding & tool holding devices.

Hobbing, broaching & grinding machines - Classification - principles of working components, work holding & tool holding devices, finishing processes.

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

Manufacturing techniques for different type of pipes (ERW, LSAW, HSAW, Seamless) and standard for pipes used in process industries.

Text/Reference Books:

1. Kalpakjian, S., & Schmid, S. (2014). Manufacturing Processes for Engineering Materials (5th ed.). Pearson India.
2. Khanna, O. P., & Lal, M. (1992). A Textbook of Production Technology, Vol II (1st ed.). Dhanpat Rai & Sons.
3. Choudhry, S. K. H. (1994). Elements of Workshop Technology, Vol II (Edition not specified). Media Promoters & Publishers.
4. HMT. (2002). Production Technology (Edition not specified). Tata McGraw-Hill.
5. Rao, P. N. (Edition not specified). Manufacturing Technology (Vol. 1, 2, 3). TMH.

Course Code	Course Name	L-T-P-Credits
PCC-ME-602	Industrial Engineering and Management	3-0-0-3

Contents:

Introduction to industrial engineering, Production Planning and Control. Value analysis and value engineering,

Plant location and layout.Job, batch, and continuous production methods.

Work study, Method study and work Measurement.
Principle of motion Economy, Therbligs, Job rating and job evaluation,

Inventory control, Classification of inventory, inventory cost, Economic order quantity, reorder point, Break-even analysis.

Replacement analysis, Replacement of items that fails, Replacement of items that Deteriorate.

Text/Reference Books:

1. Narasimhan, S. L., McLeavey, D. W., &Billington, P. J. (2014). Production Planning and Inventory Control (2nd ed.). Prentice Hall.
2. Riggs, J. L. Production Systems: Planning, Analysis and Control. Wiley.
3. Muhlemann, A., Oakland, J., & Lockyer, K.Productions and Operations Management. Macmillan.
4. Taha, H. A. Operations Research - An Introduction. Prentice Hall of India.
5. Sharma, J. K. Operations Research. Macmillan.
6. Kumar, P. Industrial Engineering and Management. Pearson India.

Course Code	Course Name	L-T-P-Credits
PCC-ME-603	**Operation Research**	**3-0-0-3**

Contents:

Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Case Studies of LPP, Graphical Methods to Solve Linear Programming Problems, Applications, Advantages, Limitations

Graphical Analysis of Linear Programming Problems: Introduction, Graphical Analysis, Some Basic Definitions, Graphical Methods to Solve LPP, Some Exceptional Cases, Important Geometric Properties of LPP

Simplex Method: Introduction, Standard Form of LPP, Fundamental theorem of LPP, Solution of LPP – Simplex Method, The Simplex Algorithm, Penalty Cost Method or Big M-method, Two Phase Method, Solved Problems on Minimisation

Duality in Linear Programming Problem: Introduction, Importance of Duality Concepts, Formulation of Dual Problem, Economic Interpretation of Duality, Sensitivity Analysis
Transportation Problem: Introduction, Formulation of Transportation Problem (TP), Transportation Algorithm (MODI Method), the Initial Basic Feasible Solution, Moving Towards Optimality

Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Routing Problem, Travelling Salesman Problem
Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT

Text/Reference Books:

1. Muhlemann, A., Oakland, J., & Lockyer, K. Productions and Operations Management. Macmillan.
2. Taha, H. A. Operations Research - An Introduction. Prentice Hall of India.
3. Sharma, J. K. Operations Research. Macmillan.
4. Kumar, P. Industrial Engineering and Management. Pearson India.

Course Code	Course Name	L-T-P-Credits
PCC-ME-604	**Machine Design**	**3-1-0-4**

Contents:

Design considerations - limits, fits and standardization, review of failure theories for static and dynamic loading (including fatigue failure),

Design of shafts under static and fatigue loadings, fatigue strength and the S-N diagram;

Analysis and design of sliding and rolling contact bearings, Selection of anti-friction bearing for different application, significance of bearing numbers, Lubricants: Lubricating oil and grease used in rotating equipment and valves

Design of transmission elements: spur & helical gears and belt drives,

Analysis of clutches and brakes.

Design of springs: helical compression, tension, torsional and leaf springs,

Design of joints: pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings,

Text/Reference Books:

1. Shigley, J. E., & Mischke, C. R. (1989). Mechanical Engineering Design (5th ed.). McGraw-Hill International.
2. Deutschman, D., Michels, W. J., & Wilson, C. E. (1992). Machine Design Theory and Practice. Macmillan.
3. Juvinall, R. C. (1994). Fundamentals of Machine Component Design. John Wiley.
4. Spotts, M. F. (1994). Design of Machine Elements (Edition not specified). Prentice-Hall India.
5. Norton, R. L. (1998). Mechanical Design – An Integrated Approach. Prentice Hall.

Course Code	Course Name	L-T-P-Credits
PCC-ME-605	**Engineering Materials**	**3-0-0-3**

Contents:

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength, NDT.

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing & impact due to carburization on metallic/machinery component of high temperature services.
nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium

Text/Reference Books:

1. Callister, W. D. (2006). Materials Science and Engineering-An Introduction (6th ed.). Wiley India.
2. Budinski, K. G., & Budinski, M. K. (2002). Engineering Materials (4th Indian Reprint). Prentice Hall of India Private Limited.
3. Raghavan, V. (1999). Material Science and Engineering. Prentice Hall of India Private Limited.
4. Jindal, U. C. (2011). Engineering Materials and Metallurgy. Pearson.

Course Code	Course Name	L-T-P-Credits
HSMC-601	Management and Accountancy	3-0-0-3

Contents:

Introduction to Management Challenges for Engineers: Introduction, definitions, employment trend in industries, STEM professionals as effective technical contributors, management and leadership, becoming effective manager in the new millennium.

Planning: Introduction, types of planning, who should do planning, inexact nature of strategic planning, planning roles for engineering managers, tools for planning, planning activities, some specific advice on planning.

Organizing: Introduction, definitions, activities of organizing, organizing one's own workplace for productivity, developing organizational structure, enhancing corporate performance by organizing examples, concurrent engineering teams, delegating, establishing working relationships, informal organizations.

Leading: Introduction, styles of leadership, leading activities, deciding, communicating, motivating, selecting engineering employees, developing people, special topics on leading.

Controlling: Introduction, setting performance standards, benchmarking, measuring performance, evaluating performance, correcting performance, means of control, general comments, control of management time, control of personnel, control of business relationships, control of projects, control of quality, control of knowledge.

Cost accounting for engineering managers: Introduction, product or service costing, application of ABC in industry, risk analysis and cost estimation under uncertainty, miscellaneous topics.

Financial Accounting and Management for Engineering Managers: Introduction, financial marketing principles, key financial statements, fundamentals of financial analysis, balanced score card, capital formation, capital assets valuation

Accounting: Principles, Concepts and conventions, Double entry system of Accounting, Introduction of basis books of accounts of sole proprietary concern, Control accounts for debtors l and creditors, closing of books of accounts and preparation of Trail Balance.

Final Accounts: Trading, Profit and Loss Accounts and Balances Sheet of Sole Proprietary concern with normal closing entries, Introduction to Manufacturing accounts of partnership firms, Limited Company. Financial Management: Meaning and role. Ratio Analysis : Meaning advantage, limitations, types of ratios and their usefulness.

Text/Reference Books:

1. Sahaf, M. A. Management Accounting: Principles & Practice.
2. Cunningham, J. E., & Fiume, O. (Edition not specified). Real Numbers: Management Accounting in a Lean Organization. Prentice Hall of India Private Limited.

3. Gupta, D. Best Management Accounting: Successful Business – Decision Making & Budgeting. Prentice Hall of India Private Limited.
4. Kaplan, R., & Atkinson, A. A. Advanced Management Accounting.

Course Code	Course Name	L-T-P-Credits
PCC-ME-606	**Heat Transfer Laboratory**	**0-0-1-1**

Contents:

Thermal conductivity of metal rod, Thermal conductivity of insulating slab, Thermal conductivity of liquids, Heat transfer through composite wall, Unsteady heat transfer, Drop wise and film wise condensation, Thermal conductivity if insulating powder, Heat transfer in natural convection, Heat transfer in forced convection, Heat pipe demonstrator, Double pipe heat exchanger, Single tube heat exchanger, Shell tube heat exchanger, Pin fin apparatus, Emissivity measuring apparatus, Multi effect evaporator, Finned tube heat exchanger, Single effect evaporator, Plate type heat exchanger, Vertical and horizontal condenser.

Text/Reference Books:

1. Bejan, A. (1993). Heat Transfer. John Wiley.
2. Cengel, Y. A., &Ghajar, A. J. (2014). Heat and Mass Transfer: Fundamentals and Applications (5th ed.). McGraw-Hill Professional.
3. Incropera, F. P., & Dewitt, D. P. (2007). Fundamentals of Heat and Mass Transfer (Sixth Edition). John Wiley.
4. Kaviany, M. (2002). Principles of Heat Transfer. John Wiley.
5. Holman, J. P. (1997). Heat Transfer (Eighth Edition). McGraw Hill.

Course Code	Course Name	L-T-P-Credits
PROJ-ME-601	**Mini Project**	**0-0-3-3**

Contents:

A relevant topic that aligns with the field of study or interest, Conduct thorough research to understand the existing knowledge, trends, and methodologies related to your chosen topic, Clearly define the objectives, Create a detailed plan outlining the steps, Execute the plan systematically, Data Analysis and Interpretation and interpret the results to draw meaningful conclusions, Reporting and Presentation.

7th semester

Course Code	Course Name	L-T-P-Credits
PEC-MEL-701	**Refrigeration and Air Conditioning (RAC)**	**3-0-03**

Contents:

Introduction to refrigeration systems, classification of refrigeration systems, review of basic thermodynamic principles: 1^{st}&2^{nd} law of thermodynamics, Heat pump Refrigerator and Heat engine difference, Joule Thomson coefficient, Tonne Refrigeration

Carnot cycle using gas and vapour as refrigerant, Vapor compression refrigeration cycle (VCR), effect of operating parameters on VCR cycle performance, Multi pressure refrigeration systems

Vapour absorbtion refrigeration system and simple analysis thereon, gas cycle refrigeration systems; simple, bootstrap, regenerative

Properties of moist air: psyrometric properties, introduction to psychrometry chart, air washer, basic psychrometry processes: process involving heating/cooling, humidification/dehumidification, total heat process, mixing of air streams, cooling load calculations, summer and winter air conditioning, introduction to comfort chart

Refrigerants and their mixtures: properties and characteristics - Ozone depletion and global warming issues - System components: Compressors, Condensers, Expansion devices and Evaporators -Performance matching of components of refrigeration systems,Application of environment friendly refrigerant mixture and equipment devices.

Text/Reference Books:

1. Gosney, W. B. (1982). Principles of Refrigeration. Cambridge University Press.
2. Stoecker, W. F., & Jones, J. W. (1986). Refrigeration and Air conditioning. Tata McGraw Hill.
3. Arora, C. P. (2000). Refrigeration and Air conditioning (2nd Edition). Tata McGraw Hill.
4. Kuehn, T. H., Ramsey, J. W., &Threlkeld, J. L. (1998). Thermal Environmental Engineering (3rd Edition). Prentice Hall.

Course Code	Course Name	L-T-P-Credits
PEC-MEL-702	Eco Friendly Design	3-0-0-3

Contents:

Introduction to Eco-friendly Design: Overview of eco-friendly design principles and concepts, Environmental impact assessment in engineering design, Role of mechanical engineers in sustainable design ,Case studies of eco-friendly engineering solutions

Sustainable Design Strategies: Design for energy efficiency, Design for resource efficiency, Design for waste reduction and recycling, Design for product longevity and durability

Renewable Energy Technologies: Introduction to renewable energy sources (solar, wind, hydropower, geothermal), Integration of renewable energy technologies in mechanical systems ,Design considerations for renewable energy systems ,Case studies of renewable energy applications in mechanical engineering

Life Cycle Assessment (LCA): Introduction to LCA and its significance in eco-friendly design ,Life cycle stages and assessment methodologies ,Environmental impact quantification and analysis ,LCA case studies in mechanical engineering

Eco-friendly Materials: Introduction to eco-friendly and sustainable materials, Selection criteria for eco-friendly materials in mechanical design ,Material substitution strategies for sustainability ,Case studies on the use of eco-friendly materials in engineering applications

Eco-friendly Design Tools and Software: Introduction to eco-design software tools ,Hands-on training in eco-design software applications ,Assessment of environmental impacts and sustainability indicators ,Optimization techniques for eco-friendly design

Module 7: Sustainable Design Projects: Group projects focusing on eco-friendly design principles, Application of sustainable design strategies in engineering projects ,Presentation and discussion of project outcomes ,Evaluation of project reports

Text/Reference Books:

1. Allen, D. T., &Shonnard, D. R. Sustainable Engineering: Concepts, Design and Case Studies. Pearson.
2. Walker, S., &Giard, J. Design for Sustainability: A Practical Approach.
3. Gauzin-Müller, D. Eco-Design for Buildings and Neighbourhoods.
4. Hauschild, M. Z., & Rosenbaum, R. K. Life Cycle Assessment: Theory and Practice.
5. Gange, D. R. W. Sustainable Materials: Processes, Production, and Recycling.

Course Code	Course Name	L-T-P-Credits
PEC-MEL-703	Computational Fluid Dynamics (CFD)	3-0-0-3

Contents:

Governing equations of fluid dynamics: Substantial derivative, Divergence of velocity, continuity, momentum, energy equations. Physical boundary conditions. Forms of governing equation suited for CFD- shock fitting and shock capturing approach. Mathematical behavior of Partial difference equations- hyperbolic, parabolic and elliptic equations.

Discritization: Finite difference method- Central, Forward, Backward difference for a uniform grid – Central difference expressions for a non-uniform grid - Numerical error - Accuracy of solution. Explicit and implicit approach. Errors and Stability analysis.

Grid Transformation: Direwct and In-direct transformation, Metric and Jacobians. Stretched grids, boundary fitted grids. Structured and unstructured grids.

Heat transfer:Conduction Heat Transfer- Applications of Heat conduction - Steady and Unsteady conductions numerical solutions of one and two dimensional steady and unsteady state problems.

Some simple CFD techniques:Numerical solution of the incompressible Navier-Stokes equations: Stream function-vorticity formulation; Primitive variable formulation; Pressure correction techniques like SIMPLE, SIMPLER, Use of CFD technique for 3D flow analysis.

Text/Reference Books:

1. Muralidhar, K., & Sundararajan, T.Computational Fluid Flow and Heat Transfer. Narosa Publishing House.
2. Ghoshdasdidar, P. S.Computer Simulation of Flow and Heat Transfer. Tata McGraw-Hill.
3. Anderson, D. A., Tannehill, J. L., & Pletcher, R. H. Computational Fluid Mechanics and Heat Transfer. Hemisphere Publishing Corporation.
4. Anderson, J. D. Computational Fluid Dynamics: The Basics with Applications. McGraw Hill.

Course Code	Course Name	L-T-P-Credits
PEC-MEL-704	Design for Manufacturing and Assembly	3-0-0-3

Contents:

Introduction to DFMA: Overview of Design for Manufacturing and Assembly, Importance of DFMA in product development, Factors influencing design decisions, Case studies and examples

Manufacturing Processes and Design Considerations: Classification of manufacturing processes, Impact of manufacturing processes on product design, Design considerations for machining, casting, forming, and additive manufacturing, Material selection for

manufacturing processes.

Assembly Methods and Design Considerations: Introduction to assembly methods: manual, automated, and robotic assembly, Assembly principles: part handling, fastening, joining, and alignment, Design considerations for ease of assembly, Case studies of successful assembly designs.

Design for Cost-Effective Manufacturing and Assembly: Cost drivers in manufacturing and assembly, Designing for cost reduction and optimization, Design for standardization and modularization, Value engineering and design for sustainability.

DFMA Tools and Software: Introduction to DFMA software tools, Hands-on training in DFMA software applications, Analysis and evaluation of design alternatives, Optimization techniques for manufacturing and assembly.

Emerging Trends in DFMA: Advanced manufacturing technologies and their impact on DFMA, Industry 4.0 and smart manufacturing, Design considerations for automation and robotics, Future prospects and challenges in DFMA.

Text/Reference Books:

1. Chitale, A. K., & Gupta, R. C. (2003). Product Design and Manufacturing. PHI.
2. Deiter, G. E. (2002). Engineering Design. McGrawHill International.
3. Boothroyd, G. (1994). Product Design for Manufacture and Assembly (1st ed.). Marcel Dekker Inc.

Course Code	Course Name	L-T-P-Credits
OEC-701	**Renewable Energy Engineering**	**3-0-0-3**

Contents:

Renewable Energy –Various renewable energy sources, overview of global and Indian energy scenario, classification and systems, environmental aspects,

Biomass Energy -Resources of biomass energy, learning the concepts of conversion of biomass energy to useful energy sources through, gasification, biogas, liquefaction & ethanol production and also developing skills to solve real life problems.

Solar Energy - Photovoltaics, application of solar thermal systems such as solar flat plate collectors and concentrators for heating needs, developing skills to determine the efficiency of the systems, harnessing solar energy from rooftop solar panel.

Hydro Energy - Micro and Small hydro plants, big dams and small hydro schemes, concept on water turbine, turbine classification, characteristics and selection of turbine and generators.

Geothermal Energy: Geothermal resources, advantages of geothermal energy, geothermal power generation, global status of electricity generation.

Ocean Energy: Ocean thermal power generation, global status of electricity generation, advantages of ocean thermal energy.

Wind Energy –Wind resource assessment, effect of terrain on wind characteristics; Classes of wind; Energy in the wind–Betz limit; Aerodynamic models, blade element theory; Evolution and progress of wind turbines; Lift and drag based wind turbines, horizontal-axis and vertical-axis wind turbines–Savonius and Darrieus turbines, Geometric and aerodynamic parameters.

Fuel Cells and Hydrogen Energy Systems -Methods of hydrogen production, Range of applications for renewable hydrogen consumption, Hydrogen storage and safety issues, Operation of fuel-cell, components and characterization.

Hybrid Energy systems -Need for hybrid systems, Types of hybrid systems, Electric and hybrid electric vehicle, Hydrogen power electric vehicle.

Text/Reference Books:

1. Khan, B. H. (2016). Non-Conventional Energy Resources (2nd ed.). Tata McGraw Hill.
2. Saeed, S. H., & Sharma, D. K. (2017). Non-Conventional Energy Resources (4th ed.). S.K. Kataria& Sons.
3. Singh, S. N. (2018). Non-Conventional Energy Resources (3rd ed.). Pearson.
4. Begamudre, R. D. (2000). Energy Conversion Systems. New Age International Publishers.
5. Smith, B. C. (1981). Energy Management Principles. Pergamon Press.
6. J F Walker J. F. and Jenkins, N., (1997). Wind Energy Technology, John Wiley and Sons.

Course Code	Course Name	L-T-P-Credits
OEC-702	**Additive Manufacturing Technology**	**3-0-0-3**

Contents:

Introduction to Additive Manufacturing, Computer Aided Process Planning for Additive Manufacturing.

Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM),

Additive Manufacturing for Industrial Applications; Additive Manufacturing for Research Applications.

Text/Reference Books:

1. Gibson, I., Rosen, D. W., & Stucker, B. (2010). Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing (2nd ed.). Springer.
2. Chua, C. K., Leong, K. F., & Lim, C. S. (2010). Rapid Prototyping: Principles and Applications (3rd ed.). World Scientific Publishers.
3. Liou, L. W., &Liou, F. W. (2007). Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development. CRC Press.
4. Kamrani, A. K., & Nasr, E. A. (2006). Rapid Prototyping: Theory and Practice. Springer.

Course Code	Course Name	L-T-P-Credits
OEC-703	Power Plant Engineering	3-0-0-3

Contents:

Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems

Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

Text/Reference Books:

1. Nag, P. K. (2008). Power Plant Engineering (3rd ed.). Tata McGraw Hill.
2. El Wakil, M. M. (2010). Power Plant Technology. Tata McGraw Hill.
3. Elliot, T. C., Chen, K., &Swanekamp, R. C. (1998). Power Plant Engineering (2nd ed.). McGraw Hill.

Course Code	Course Name	L-T-P-Credits
OEC-704	Die Mold Tool Design	3-0-0-3

Contents:

Introduction to Die, Mold, and Tool Design: Definition of dies, molds, and tools, Importance of die, mold, and tool design, Applications of die, mold, and tool design
Types of Dies, Molds, and Tools: Classification of dies, molds, and tools, Design principles for various types of dies, molds, and tools, Selection of materials for various types of dies, molds, and tools
Design Principles for Dies, Molds, and Tools: Basic design considerations for dies, molds, and tools, Analysis of part geometry and material properties, Design of gating, runners, and sprues,Mold cavity and core design
Materials Selection for Dies, Molds, and Tools: Selection of materials for dies, molds, and tools, Heat treatment and surface treatment of dies, molds, and tools, Fatigue and wear characteristics of materials used in dies, molds, and tools
Injection Molding and Die Casting: Injection molding process, Die casting process, Design

principles for injection molding and die casting dies
Plastic Part Design for Injection Molding: Guidelines for designing parts for injection molding, Design principles for various types of injection molding parts

Text/Reference Books:

1. Paquin, J. R., & Crowley, R. A.Die Design Fundamentals. Industrial Press Inc.
2. DuBois, J. H. (n.d.). Mold Design and Moldmaking for Plastics. Hanser Publishers.
3. Donaldson, C., &Goold, W. Tool Design. Tata McGraw Hill.

Course Code	Course Name	L-T-P-Credits
PROJ-ME-701	**Engineering Project -1**	**0-0-6-6**

Contents:

Choose a relevant and interesting topic that aligns with the field of study or interest, Conduct thorough research to understand the existing knowledge, trends, and methodologies related to your chosen topic, Clearly define the objectives, Create a detailed plan outlining the steps, Execute the plan systematically, Data Analysis and Interpretation and interpret the results to draw meaningful conclusions, Reporting and Presentation.

Course Code	Course Name	L-T-P-Credits
ME-I-701	**Internship-3**	**0-0-3-3**

Contents:

Internship: Gain practical experience in an organization for skill development, report preparation, presentation, and certification. Submission of report at department, presentation or viva for evaluation.

8th semester

Course Code	Course Name	L-T-P-Credits
PEC-MEL-801	Automobile Engineering	3-0-0-3

Contents:

History of automobiles; Classification of automobiles; Power plant classification; Engine terminology; Types of cycles; Working principle of an IC engine; Advanced classification of engines and multi cylinder engines; Engine balance and firing order.

Fuel System, Ignition System and Electrical system: *Spark Ignition engines* – fuel tank, fuel filter, fuel pump, air filter, carburetor, direct injection of petrol engines; MPFI, *Compression Ignition engines* –fuel injection (air and solid), pressure charging, super charging and turbo charging; *Ignition systems*– components, battery ignition, magneto ignition, electronic ignition and ignition timing; *Main electrical circuits* – generating & starting circuit, lighting, indicating devices, Catalytic convertor, pollution controls norms in BS-VI.

Lubricating System and Cooling System: Functions & properties of lubricants, methods of lubrication; Oil filters, oil pumps, oil coolers; Characteristics of an effective cooling system; types of cooling systems; Radiator, thermostat, air cooling & water cooling.

Chassis & Transmission: Parts of automobile body; *Automobile frames* – functions, constructions, sub frames, materials and defects; *Transmission* – axles, clutches, propeller shafts, differential, gear boxes, automatic transmission, electronic transmission control, functions and types of front and rear axles, types and functions of clutches, Hotchkiss drive torque tube drive, traction control.

Steering mechanism, steering gear box types, wheel geometry; Brakes – principle, functions, types, construction, operation and parking brake; *Suspension* - types of spring shock absorbers, objectives and types of suspension system, rear axle suspension, electronic control and proactive suspension system.

Automotive Air Conditioning: Ventilation, heating, air condition, refrigerant, compressor and evaporator.

Wheels and Tyres: Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications.

Recent Trends: E-vehicles; Satellite-based navigation; Automated steering; Environment effect and mitigation.

Text /Reference Books:

1. Babu, A.K. & Sharma, S.C. (2019). Automobile Mechanics. Khanna Book Publishing.
2. Babu, A.K. & Sharma, S.C. (2019). Automobile Engines. Khanna Book Publishing.
3. Singh, K. (1997). Automobile Engineering (7th ed.). Standard Publishers.
4. Jain, K.K. & Asthana, R.B. (2002). Automobile Engineering. Tata McGraw Hill.
5. Heitner, J. (1999). Automotive Mechanics (2nd ed.). East-West Press.
6. Heisler, H. (1998). Advanced Engine Technology. SAE International Publ.

Course Code	Course Name	L-T-P-Credits
PEC-MEL-802	**Nuclear Engineering**	**3-0-0-3**

Contents:

Introduction to Nuclear Engineering: Historical development of nuclear engineering, Basics of nuclear physics, Nuclear reactions and radiation.

Nuclear Reactors: Types of nuclear reactors, Reactor materials and fuels, Reactor cooling systems, Reactor instrumentation and control.

Reactor Design and Operation: Reactor core design and analysis, Reactor startup and shutdown procedures, Reactor safety analysis.

Radiation Protection: Sources of radiation exposure, Radiation detection and measurement, Radiation shielding.

Nuclear Waste Management: Types of nuclear waste, Waste disposal methods, Environmental impact assessment.

Advanced Topics in Nuclear Engineering: Fusion reactors and their principles, Emerging nuclear reactor designs and technologies, Nuclear non-proliferation and international safeguards.

Text /Reference Books:

1. Glasstone, S. &Sesonske, A. (2013). Nuclear Reactor Engineering: Reactor Design Basics (1st ed.). CRC Press.
2. Lamarsh, J.R. &Baratta, A.J. (2018). Introduction to Nuclear Engineering (4th ed.). Pearson.
3. Todreas, N.E. & Kazimi, M.S. (2013). Nuclear Systems Volume I: Thermal Hydraulic Fundamentals (2nd ed.). CRC Press.

Course Code	Course Name	L-T-P-Credits
OEC-801	**Aerospace Engineering**	**3-0-0-3**

Contents:

Introduction to aerospace vehicles: Brief history of aerospace engineering, Aerospace industry and its role in the economy.

Standard atmosphere: Definition of standard atmosphere, geometric, absolute, geo-potential altitudes, pressure, temperature and density altitudes.

Aerodynamics: Wind tunnels and their application, measurement of airspeed, airfoils and wings; airfoil nomenclature, lift, drag and moment coefficients, infinite and finite wings, critical Mach number, induced drag, swept wings, high-lift devices.

Aircraft performance: Drag polar, cruising, climbing, and gliding flight; range and endurance;

takeoff and landing flights; turning performance and V-n diagram.

Propulsion: Aircraft propulsion – piston-prop, turbojet, turboprop, turbofan, turbo-shaft and ramjet engines; general thrust equation, propulsive efficiency; two and three spool configurations.

Aircraft Structures and Materials: Introduction to aircraft structures, Types of loads on aircraft structures, Stress and strain analysis, Failure criteria, Structural materials and their properties,

Space Flight and Rocket Propulsion: Basics of space flight, Chemical, electrical and nuclear rockets; Applications of rockets in launch vehicles, spacecraft, and missiles.

Text /Reference Books:

1. Anderson, J. D. (2017). Introduction to Flight (8th ed.). McGraw Hill Education.
2. Shevell, R. A. (1989). Fundamentals of Flight, Pearson Education.
3. Newman, D. (2002). Interactive Aerospace Engineering and Design, McGraw-Hill.
4. Roskam, J. (2018). Airplane Design, Part I-VIII. Darcorporation.
5. Sutton, G. P. and Biblarz, O. (2001). Rocket Propulsion Elements, Wiley.
6. Ward, T. A. (2010). Aerospace Propulsion Systems, Wiley.

Course Code	Course Name	L-T-P-Credits
OEC-802	**Marine Engineering**	**3-0-0-3**

Contents:

Introduction to Marine Engineering: Overview of marine engineering and its importance, Introduction to marine vessels and their types, Basics of ship design and construction, Maritime regulations and classification societies.

Ship Hydrostatics and Stability: Buoyancy and Archimedes' principle, Ship geometry and definitions, Ship stability calculations, Effects of weight distribution and loading conditions, Intact and damaged stability.
Marine Power Plants: Steam power plants for marine applications, Diesel engines for propulsion, Gas turbine power plants, Combined power plants, Performance characteristics and selection criteria.

Ship Propulsion Systems: Types of propellers and their design principles, Propulsion system components (shafting, bearings, seals), Controllable pitch propellers, Waterjet propulsion systems, Thrusters, and maneuvering systems.

Marine Heat Transfer and HVAC Systems: Heat transfer principles in marine applications, Boiler systems and heat exchangers, Refrigeration and air conditioning systems, Ventilation and air distribution in ships, Environmental considerations, and energy efficiency.

Marine Materials and Corrosion Control: Selection of materials for marine applications, Corrosion mechanisms and prevention techniques, Cathodic protection and coatings, Material degradation in marine environments, Non-destructive testing techniques.

Ship Structures and Naval Architecture: Ship structural components and design principles, Structural analysis and strength calculations, Shipbuilding materials and fabrication

techniques, Ship construction methods and processes, Stability considerations in ship design.

Marine Safety and Environmental Protection: Shipboard safety procedures and emergency preparedness, Fire safety and prevention in marine environments, Pollution prevention and control measures, international conventions and regulations, Risk assessment and management.

Text /Reference Books:

1. Taylor, D.A. (2010). Introduction to Marine Engineering (3rd ed.). Butterworth-Heinemann.
2. Brinkworth, A.G. (1992). Marine Engineering: Thermodynamics and Heat Transmission. Butterworth-Heinemann.
3. Eyres, D.J. (2007). Ship Construction (6th ed.). Butterworth-Heinemann.
4. George, T. (2010). Marine Engineering: Principles and Practice (3rd ed.). Butterworth-Heinemann.
5. Papanikolaou, A.C. (2000). Marine Engineering: Theoretical and Applied Mechanics. Butterworth-Heinemann.
6. Vesilind, P.A. (2015). Marine Engineering Systems (2nd ed.). CRC Press.
7. Liu, H.T. (2012). Marine Engineering: Renewables and Environmental Impact. CRC Press.
8. Barrass, B. (2011). Ship Stability for Masters and Mates (6th ed.). Butterworth-Heinemann.

Course Code	Course Name	L-T-P-Credits
PROJ-ME-801	**Engineering Project-2**	**0-0-6-6**

Contents:

Choose a relevant and interesting topic that aligns with the field of study or interest, Conduct thorough research to understand the existing knowledge, trends, and methodologies related to your chosen topic, Clearly define the objectives, Create a detailed plan outlining the steps, Execute the plan systematically, Data Analysis and Interpretation and interpret the results to draw meaningful conclusions, Reporting and Presentation.

Course Code	Course Name	L-T-P-Credits
ME-V-801	**Composite Viva**	**0-0-2-2**

Contents:

The composite viva for B.Tech Mechanical Engineering covers all subjects studied over four years: Prepare to discuss fundamental principles, equations, and real-world applications, problem-solving and understanding recent advancements.

Minor Degree Course in Additive Manufacturing

MINOR DEGREE COURSES

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	PCC-MEM-501	Fundamentals of Additive Manufacturing	3	0	0	3	5
2	PCC-MEM-601	Product Design and Prototyping	3	0	0	3	6
3	PCC-MEM-701	Advanced Physical and Mechanical Metallurgy	3	0	0	3	7
4	PCC-MEM-702	Additive Manufacturing Processes Lab	0	0	4	2	7
5	PCC-MEM-EL-801/802	Elective-I (Finite Element Method/ Machine Learning applications)	3	1	0	4	8
6	PCC-MEM-EL-803/804	Elective-II (3D printing/ Industry 4.0)	3	0	0	3	8
Total Credits:						**18**	

Course Code	Course Name	L-T-P-Credits	Semester
PCC-MEM-501	**Fundamentals of Additive manufacturing**	**3-0-0-3**	**5**

Contents:

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.
Z-Corporation 3D-printing, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS),

Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transfer redarc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM),Metal inert gas additive manufacturing (MIGAM).
Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process

Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing.

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials. Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating.

Thermal model to predict size of deposition such as width and height of deposition, Finite element simulation of additive process.

Text/Reference Books:

1. Gibson, I., Rosen, D.W., & Stucker, B. (2010). Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing. Springer.
2. Chua, C.K., Leong, K.F., & Lim, C.S. (2010). Rapid Prototyping: Principles and Applications (3rd ed.). World Scientific Publishers.
3. Chua, C.K., Leong, K.F., & Lim, C.S. (2014). 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping. World Scientific Publishers.
4. Gebhardt, A. (2003). Rapid Prototyping. Hanser Gardener Publications.
5. Liou, L.W., &Liou, F.W. (2007). Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development. CRC Press.
6. Kamrani, A.K., & Nasr, E.A. (2006). Rapid Prototyping: Theory and Practice. Springer.
7. Mahamood, R.M. (2018). Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes. Springer International Publishing AG.
8. Toyserkani, E., Khajepour, A., & Corbin, S.F. (2004). Laser Cladding. CRC Press.

Course Code	Course Name	L-T-P-Credits	Semester
PCC-MEM-601	**Product Design and Prototyping**	**3-0-0-3**	**6**

Contents:

Introduction to course, Product life-cycle, Product policy of an organization. Selection of a profitable product, Product design process, Product analysis.

Value engineering in product design; Advantages, Applications in product design, Problem identification and selection, Analysis of functions, Anatomy of function. Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST).

Introduction to product design tools, QFD, Computer Aided Design, Robust design, DFX, DFM, DFA, Ergonomics in product design.

DFMA guidelines, Product design for manual assembly, Design guidelines for metallic and nonmetallic products to be manufactured by different processes such as casting, machining, injection molding etc., Rapid prototyping, needs, advantages, working principle of SLA,

LOM and SLS.

Text/Reference Books:

1. Eppinger, S., & Ulrich, K. (2008). Product Design and Development (4th ed.). McGraw-Hill Higher Education.
2. Green, W., & Jordan, P.W. (Eds.). (1999). Human Factors in Product Design: Current Practice and Future Trends. CRC Press.
3. Eppinger, S., Ulrich, K., & Yang, M.C. (2019). Product Design and Development (7th ed.). McGraw Hill.
4. Roozenburg, N.F., &Eekels, J. (1995). Product Design: Fundamentals and Methods (Vol. 2). John Wiley & Sons Inc.
5. Lidwell, W., Holden, K., & Butler, J. (2010). Universal Principles of Design, Revised and Updated: 125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach Through Design. Rockport Pub.

Course Code	Course Name	L-T-P-Credits	Semester
PCC-MEM-701	**Advanced Physical and Mechanical Metallurgy**	**3-0-0-3**	**7**

Contents:

Microstructure & Properties: solidification and solidification structures, interfaces, crystallographic texture, residual stress, structure-property relations.
Plasticity and work hardening: fundamentals, stress-strain behavior, fracture, creep & deformation mechanisms. Recovery, recrystallization, grain growth.

Phase transformation: thermodynamic basics, nucleation and growth,

Spinodal decomposition, martensitic transformations

Text/Reference Books:

1. Courtney, T.H. (2000). Mechanical Behavior of Materials (2nd ed.). McGraw-Hill.
2. Cahn, R.W., Haasen, P., & Kramer, E.J. (Eds.). (1993). Materials Science and Technology: A Comprehensive Treatment. VCH.
3. Smallman, R.E., & Ngan, A.H.W. (2007). Physical Metallurgy & Advanced Materials (7th ed.). Elsevier.
4. Martin, J.W., Doherty, R.D., & Cantor, B. (1997). Stability of Microstructures in Metallic Systems (2nd ed.). Cambridge University Press.
5. Porter, D.A., & Easterling, K.E. (1986). Phase Transformations in Metals and Alloys. Van Nostrand Reinhold.

Course Code	Course Name	L-T-P-Credits	Semester
PCC-MEM-702	**Additive Manufacturing Processes Lab**	**0-0-2-2**	**7**

Contents:
Laboratory syllabus: CAD Modeling: Introduction to CAD environment, Sketching, Modeling and Editing features, Different fileformats, Export/Import geometries, Part

orientation, Slicing, Support generation-FDM/SLA, Process path selection, Printing-FDM/SLA.

Text/Reference Books:

1. Chua, C.K., Leong, K.F., & Lim, C.S. (2010). Rapid Prototyping: Principles and Applications (3rd ed.). World Scientific Publishers.
2. Liou, L.W., &Liou, F.W. (2011). Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development. CRC Press.
3. Kamrani, A.K., & Nasr, E.A. (2006). Rapid Prototyping: Theory and Practice (1st ed.). Springer.
4. Hilton, P.D., & Jacobs, P.F. (2005). Rapid Tooling: Technologies and Industrial Applications. CRC Press.

Course Code	Course Name	L-T-P-Credits	Semester
PCC-MEM-EL-801	**Finite Element Method (Professional Elective Course [1])**	**3-1-0-4**	**8**

Contents:

Introduction to Finite Element Methods: General Procedure – Engineering Applications – Stress and Equilibrium, Strain – Displacement relations. Stress – strain relations: Finite Elements: 1- Dimensional, 2 – Dimensional, 3-Dimensional & Interpolation Elements

One Dimensional Problems: 1-D Linear and 1-D Quadratic Elements – Finite element modeling, Coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

Analysis of Trusses: Derivation of Stiffness Matrix for Plane Truss, Displacement of Stress Calculations.

Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection.

Finite element modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Estimation of Load Vector, Stresses
Finite element modeling of Axis-symmetric solids subjected to Axi-symmetric loading with triangular elements. Two dimensional four noded Isoparametric elements and numerical integration.

Steady State Heat Transfer Analysis: one dimensional analysis of Slab, fin and two-dimensional analysis of thin plate.

Dynamic Analysis: Formulation of finite element model, element – Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss and beam.
Finite element – formulation to 3 D problems in stress analysis, convergence requirements, Mesh generation. techniques such as semi-automatic and fully Automatic use of softwares such as ANSYS, ABAQUS, NASTRAN using Hexahedral and Tetrahedral Elements, Use of 3D modeling for flow analysis in centrifugal pumps.

Text/Reference Books:

1. Krishnamoorty, C.S. (2017). Finite Element Analysis: Theory and Programming (2nd ed.). McGraw Hill.
2. Maity, D. (2007). Computer Analysis of Framed Structures. I.K. International Pvt. Ltd.
3. Thompson, E.G. (1991). Introduction to the Finite Element Method: Theory, Programming and Applications. John Wiley.
4. Martin, H.C., & Carey, G.F. (1982). Introduction to Finite Element Analysis - Theory and Application. McGraw-Hill.
5. Shames, I.H., &Dym, C.L. (1985). Energy and Finite Element Methods in Structural Mechanics. New Age International.
6. Bathe, K.J. (2005). Finite Element Procedures. Prentice-Hall of India.
7. Mukhopadhyay, M. (2002). Matrix, Finite Element, Computer and Structural Analysis. Oxford and IBH Publishing Co. Pvt. Ltd.
8. Zienkiewicz, O.C., & Cheung, Y.K. (1967). The Finite Element Method in Structural and Solid Mechanics. McGraw Hill.
9. Ceruzzi, P.E. (1998). A History of Modern Computing. The MIT Press.
10. Cook, R.D. (2001). Concepts and Applications of Finite Element Analysis. Wiley.
11. Rao, S.S. (2004). Finite Element Analysis. Elsevier Butterworth-Heinemann.
12. Weaver Jr., W., & Gere, J.M. (1975). Matrix Analysis of Framed Structures. CBS Publishers & Distributors.

Course Code	Course Name	L-T-P-Credits	Semester
PCC-MEM-EL-802	**Machine Learning Applications (Professional Elective Course[I])**	**3-1-0-4**	**8**

Contents:

Basics of python & machine learning, Terminologies in machine learning, Types of machine learning: supervised, unsupervised, semi-supervised learning.

Discriminative Models: Least Square Regression, Gradient Descent Algorithm, Univariate and Multivariate Linear Regression, probabilistic interpretation, Regularization, Logistic regression, multi class classification, kernel functions, SMO algorithm, SVM

Decision tree & random forest
K fold validation &Klustering

K nearest algorithm, Principal component analysis, Bias Vs variance, ensemble

Text/Reference Books:

1. Mitchell, T. (1997). Machine Learning. McGraw Hill.
2. Alpaydin, E. (2010). Introduction to Machine Learning (2nd ed.). MIT Press.
3. Geron, A. (2017). Hands-On Machine Learning with Scikit-Learn and TensorFlow. Shroff/O'Reilly.
4. Muller, A., & Guido, S. (2016). Introduction to Machine Learning with Python: A Guide for Data Scientists. Shroff/O'Reilly.

Course Code	Course Name	L-T-P-Credits
PCC-MEM-EL-803	3D printing (Professional Elective Course [II])	3-0-0-3

Contents:

Introduction to Design, Prototyping fundamentals. Introduction to 3D printing, its historical development, advantages. Commonly used terms, process chain, 3D modelling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, RP data formats, Classification of 3D printing process, Applications to various fields.

Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.

Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration

Text/Reference Books:

1. Chua, C.K., Leong, K.F., & Lim, C.S. (2010). Rapid Prototyping: Principles and Applications (3rd ed.). World Scientific Publications.
2. Pham, D.T., &Dimov, S.S. (2001). Rapid Manufacturing. Springer.
3. Jacobs, P.F. (1996). Rapid Prototyping and Manufacturing. ASME Press.
4. Gibson, I., Rosen, D., & Stucker, B. (2014). Additive Manufacturing Technologies (2nd ed.). Springer.
5. Wohlers, T. (2000). Wohlers Report 2000. Wohlers Associates.

Course Code	Course Name	L-T-P-Credits
PCC-MEM-EL-804	Industry 4.0 (Professional Elective Course [II])	3-0-0-3

Contents:

Introduction to Industry 4.0, Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0, production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0,

A Conceptual Framework for Industry 4.0, Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.

Technology Roadmap for Industry 4.0: Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.

Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.

The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR.

Obstacles and Framework Conditions for Industry 4.0,
Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, state support, legal framework, protection of corporate data, liability, handling personal data.

Text/Reference Books:

1. Ustundag, A., &Cevikcan, E. (2017). Industry 4.0: Managing the Digital Transformation (1st ed.). Springer.
2. Bartodziej, C.J. (2018). The Concept Industry 4.0. Springer.
3. Schwab, K. (2016). The Fourth Industrial Revolution (1st ed.). Crown Business.
4. Schröder, C. (2018). The Challenges of Industry 4.0 for Small and Medium-sized Enterprises1st ed.). Springer.