SHIVAJI UNIVERSITY, KOLHAPUR
416 004, MAHARASHTRA
PHONE : EPABX – 2609000, BOS Section – 0231-2609094, 2609487
Web : www.unishivaji.ac.in Email: bos@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर ४१६ ००४, महाराष्ट्र
दूरध्वनी - इपीबीएक्स - २०६०९०००, अभ्यासमंडळे विभाग : ०२३१- २६०९०९४, २६०९४८७
वेबसाईट : www.unishivaji.ac.in ईमेल : bos@unishivaji.ac.in

Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SU/BOS/Sci & Tech/ 316 **Date: 23/05/2025**

To,

The Director,
School of Engineering and Technology,
Shivaji University, Kolhapur.

Subject: Regarding revised syllabus of **B. Tech.** Part - III (Sem - V & VI) degree **Programme (Deparment of Technolgy)** under the Faculty of Science and Technology as per NEP 2020.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, Nature of Question paper and equivalence of B. Tech. Part - III (Sem - V & VI) under the Faculty of Science & Technology as per NEP 2020.

No.	Course Syllabus
1	Civil Engineering
2	Mechanical Engineering
3	Computer Science and Technology
4	Chemical Engineering
5	Electronics and Telecommunication Engineering
6	Food Technology

This Syllabus, shall be implemented from the academic year **2025-26** onwards. A soft copy containing the syllabus is attached herewith and it is available on university website **www.unishivaji.ac.in NEP-2020@suk (Online Syllabus).**

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October/ November 2025 & March / April 2026. These chances are available for repeater students, if any

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dr. S. M. Kubal
Dy. Registrar

Copy to: for Information and necessary action

1	The I/c Dean, Faculty of Science & Technology	6	Appointment Section A & B
2	Director, Board of Examinations & Evaluation	7	Affiliation Section (T.1) (T.2)
3	The Chairpersan, Respective Board of Studies	8	P.G.Admission Section, /P.G Seminar Section
4	OE 4 Exam Section,	9	Computer Centrev/ IT Cell
5	Eligibility Section,	10	Internal Quality Assorance Cell (IQAC)

SHIVAJI UNIVERSITY, KOLHAPUR

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New Syllabus for

Third Year B. Tech (Mechanical Engineering)

UNDER

Faculty of Science and Technology

B. Tech (Mechanical Engineering) –Semester V & VI

STRUCTURE AND SYLLABUS ACCORDING WITH NATIONAL EDUCATION POLICY – 2020 WITH MULTIPLE ENTRY AND MULTIPLE EXIT OPTIONS

(TO BE IMPLIMATED FORM ACADEMIC YEAR 2025-26 ONWORDS)

Engineering Graduate Attributes

1. Domain specific Engineering Knowledge
2. Problem Analysis Ability
3. Acquiring Skills that enable them to Design & Develop Solutions to the Problems
4. Capacity to investigate Complex Problems
5. Familiarity of using Modern Tools
6. Understanding Engineer's role and connectivity towards Society
7. Awareness about Environment & Sustainability
8. Practicing ethics and values
9. Ability to work as an Individual & in a Team also
10. Acquiring Communication skills
11. Becoming well verse with task of Project management & Finance aspects
12. Developing Lifelong Learning attitude

Note: For every program, there are its own Program Educational Objectives (PEOs) while there are 12 Program Outcomes (POs) which are aligned with these graduate attributes for the engineers.

B. Vision, Mission, PEO's and PO's

1. Vision To be a premier center of engineering education and industrial research that provides excellent academic ambience and nurtures innate talents of students to become technically sound, application oriented, innovative and successful mechanical engineers .

2. Mission To empower students with the fundamentals of Mechanical Engineering through innovative curriculum and effective teaching thereby enabling them for successful career by imparting knowledge, skills and right attitude and a spirit to serve the society with professional ethics.

3. Programme Educational Objectives (PEO's)

Graduate should:

1. Demonstrate successful professional careers with strong fundamental knowledge in Science, Mathematics, English and Engineering Sciences so as to enable them to analyze the Mechanical Engineering related problems leading to leadership, entrepreneurship or pursuing higher education

2. Acquire technical knowledge in specialized areas of Mechanical Engineering such as Materials, Design, Manufacturing and Thermal Engineering with a focus on research, innovation and gaining the technical skills in advanced software packages.

3. Work with multidisciplinary field of engineering and technology to enlarge the ability among the students to understand the different industrial environments.

4. Continuously learn, research and develop with strong professional, moral and ethical

values and with a zeal for life-long learning.

4. Programme Outcomes (PO's)

An engineering graduate of Mechanical Engineering Programme at Department of Technology by the time of graduation will achieve and demonstrate:

a) An ability to apply basic knowledge of science, mathematics and engineering fundamentals in the field of Mechanical Engineering.

b) An ability to identify, formulates, review research literature and analyze mechanical engineering problems using basics principles of science, mathematics and engineering.

C. Component wise distribution of credits

(Expected range of credits as per AICTE & NEP2020 guidelines is 160-176)

*Please note that most of the courses under HSMEC have been covered under audit courses.

Sr. No.	Category Suggested	Course Code	No. of Credits	Components %
1.	Humanities and Social Sciences including Management & Environment Courses	HSMEC	02	1.13
2.	Indian Knowledge System	IKS	03	1.70
3.	Ability Enhancement Course	AEC	03	1.70
4.	Value Education Courses	VEC	02	1.13
5.	Basic Science courses	BSC	20	11.37
6.	Engineering Science Courses including workshop, drawing, basics of civil/electrical/mechanical/computer etc.	ESC	34	19.32
7.	Professional Core Courses	PCC	65	36. 93
8.	Professional Elective Courses relevant to chosen specialization/branch	PEC	12	6.82
9.	Open subjects – Electives from other technical and /or emerging subjects	OEC	06	3.41
10.	Project , Seminar and Internship	PSI	17	9.65
11.	Multidisciplinary Minor	MDM	14	7.95
12.	Vocational and Skill Enhancement Courses	VSEC	Audit Courses	-
13.	Project Based Learning	PBL		
14.	Mandatory Audit Courses [Some other courses Decided at the Institute level but that do not get fit in the credits]	MAC (HSMEC)*		
	Total		176	**100**

Shivaji University,
Kolhapur
Department of Technology

Third Year B. Tech (Mechanical Engineering), Semester- V

Teaching & Evaluation Scheme

S.N.	Category	Course Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Professional Core Course	PCC311	Heat and Mass Transfer	03	-	02	05	04	30:70	00:50
2.	Professional Core Course	PCC312	Industrial Engineering and Management	03	-	-	03	03	30:70	00:00
3.	Professional Core Course	PCC313	Machine Design II	03	-	02	05	04	30:70	50:50
4.	Professional Core Course	PCC314	Dynamics of Machines	03	-	-	03	03	30:70	00:00
5.	Engineering Science Courses	ESC311	CAD/CAM/CAE	01	-	02	03	02	00:00	50:50
6.	Professional Core Course	PCC315	Elective I	03	-	-	03	03	30:70	00:00
7.	MDM Course	MDM 311	Multidisciplinary Minor Course II*	03	-	-	03	03	30:70	00:00
8.	Ability Enhancement Courses	AEC311	Introduction to Foreign Language	01	-	-	01	01	00:00	50:00
				-	-	-	-	23	600	300
9.	Mandatory Audit Course	MAC312	Aptitude Enhancement Course II		01	-	01	ISE at Course in charge end		
10	Project Based Learning	PBL311	Mini Project III & Industrial Visit		-	02	02	ISE at Course in charge end		
			Total Hours	**20**	**01**	**08**	**29**	-	-	-

Shivaji University, Kolhapur
Department of Technology

Third Year B. Tech (Mechanical Engineering), Semester-VI
& Evaluation Scheme

S.N.	Category	Course Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Professional Core Course	PCC321	Control Engineering	03	01	-	04	04	30:70	00:00
2.	Professional Core Course	PCC322	Metrology and Quality Control	03	-	02	05	04	30:70	50:50
3.	Professional Core Course	PCC323	Internal Combustion Engines	03	-	02	05	04	30:70	50:50
4.	Open Elective Course	OEC321	Open Elective –I	03	-	-	03	03	30:70	00:00
5.	Elective Course	EEC321	Elective –II	03	-	-	03	03	30:70	00:00
6.	MDM Course	MDM 321	Multidisciplinary Minor Course III*	03	-	-	03	03	30:70	00:00
7.	Ability Enhancement Courses	AEC321	Mini Project IV & Industrial Visit	02	-	-	02	02	00:00	50:50
				-	**-**	**-**	**-**	**23**	**500**	**300**
8.	Mandatory Audit Course	MAC322	Aptitude Enhancement Course III	-	01	-	01	ISE at Course in charge end		
9.	Mandatory Audit Course	PBL321	Design Thinking & Innovation – III	-	-	02	02	ISE at Course in charge end		
			Total Hours	**20**	**02**	**06**	**28**	-	-	-

- Note :- The MDM course will be chosen from the Multidisciplinary Minor Title.

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PCC311							
Course Category	Professional Core Course Heat and Mass Transfer							
Course title	**Heat and Mass Transfer**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	3	**-**	**2**	**5**		**4**		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**	
	30	70	-	-	-	50		
Pre-requisites(if any)								
Course Objectives	1 To familiarize the students with fundamental principles/laws of heat transfer by conduction, convection, and radiation and mass transfer by diffusion and convection. 2 To introduce the various heat and mass transfer mechanisms that characterize a given physical system. 3 To familiarize conservation equations along with models for heat transfer processes. 4 To prepare the analysis of one-dimensional steady and unsteady partial differential equations. 5 To develop representative models of real-life heat transfer processes and systems. 6 To introduce the various heat and mass transfer mechanisms that characterize a given physical system.							
Course Outcomes	1 Demonstrate the basic laws of heat and mass transfer and compute the heat transfer 2 Analyze problems involving steady and transient state heat transfer. 3 Analyze various types of applications related to heat transfer like fins, heat exchangers, wire insulation 4 Asses the heat exchanger performance by using the LMTD and NTU.							

Unit No.	Course Content	Hours
1	Introduction to Heat Transfer Introduction to Heat transfer, Difference between thermodynamics and heat transfer, Modes of heat transfer, thermo-physical properties, Thermal conductivity and coefficient of heat transfer. Electrical analogy and thermal resistance in conduction, convection and radiation,	3

2	Heat Conduction. Heat conduction through a plane wall, cylindrical wall and sphere. Heat conduction through a composite slab, cylinder and sphere, effect of variable thermal conductivity, critical radius of insulation, and thermal contact resistance. Numerical problems on One dimensional steady state heat conduction for plane wall, cylinder and sphere. Extended Surfaces: Types and Applications of Fins, Heat transfer through extended surfaces, derivation of temperature distribution equations and heat transfer through fins of constant cross- sectional area, Effectiveness and efficiency of a fin.	8
3	Convection Local and average convective coefficient, Hydrodynamic and thermal boundary layer, Laminar and turbulent flow over a flat plate and through a duct, Friction factor, Drag and drag co-efficient. Dimensional analysis in free and forced convection, the physical significance of the dimensionless numbers related to free and forced convection, empirical correlations for free and forced convection for heat transfer in laminar and turbulent flow over a flat plate and through a duct. Numerical problems on convection.	8
4	Radiation. Nature of thermal radiation, definitions of absorptivity, reflectivity, transmissivity, monochromatic emissive power, total emissive power and emissivity. Concept of black body and gray body. Kirchhoff laws, Wien's law and Planck's law. Deduction of Stefan Boltzmann equation. Lambert's cosine rule, Intensity of radiation. Energy change by radiation between two black surfaces with non-absorbing medium in between and in absence of reradiating surfaces. Geometric shape factor. Energy exchange by radiation between two gray surfaces without absorbing medium and absence of radiation and radiosity. Numerical problems on radiation laws.	8
5	Heat Exchanger Heat Exchangers, Classification according to flow arrangement, Tubular heat exchangers. Fouling factor, mean temperature difference, LMTD for parallel flow, counter flow, mean temperature for cross flow, correction factor, and special cases. The effectiveness by NTU method, effectiveness of parallel, counter flow. Basic working of condenser and evaporator heat exchanger, types of condenser and evaporator. Numerical on LMTD methods.	7
6	Boiling and condensation. Nucleate and film boiling phenomenon: drop wise and film wise condensation, Nusselt's theory of condensation nature of heat transfer in such phenomenon. Introduction to Mass Transfer: Introduction, modes of mass transfer, analogy between heat and mass transfer, Mass diffusion, Fick's law of diffusion.	5

Suggested list of Assignments:

1. Modes of heat transfer.
2. Conduction
3. Fins and Extended surface
4. Convection
5. Radiation
6. Heat exchanger
7. Boiling and condensation

General Instructions:

Each Student has to write at least 6 assignments on entire syllabus.

Text Books	
1	“Heat Transfer”, J.P. Holman, Tata McGraw Hill Book Company, New York, 2nd Edition.
2	“Fundamentals of Heat and Mass Transfer”, R.C. Sachdeva, Willey Eastern Ltd.,
3	“A Text Book on Heat Transfer”, Dr. S. P. Sukhatme, Orient Longman, Hyderabad.
Reference Books	
1	“Heat Transfer – A Practical approach”,Yunus. A .Cengel, Tata McGraw Hill.
2	“Heat Transfer” Chapman A.J., Tata McGraw Hill Book Company, New York.
3	“Fundamentals of Heat and Mass Transfer”, Frank P.Incropera, David, P.Dewitt, Wisley India. 5th Edition.
Useful web links	
1	http://www.sciencedirect.com/science/bookseries
2	http://www.thermalfluidscentral.org/e-books
3	http://www.elsevier.com/books/advances-in-heat-transfer

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PCC311							
Course Category	Professional Core Course							
Course title	**Heat and Mass Transfer- Lab**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	3	**-**	**2**	**5**		**4**		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**	
	30	70				50	150	
Pre-requisites(if any)	--							
Course Objectives	1. To understand and execute experiments 2. To understand measuring equipment and apply 3. To Analyse the data from the experiment and correlate it to basic 4. To apply learning in evaluating heat exchanger performance							
Course Outcomes	1. Students will able to interpret the results 2. Students will able to set processes for experimentation 3. Students will able to understand the basics of the subject through experience 4. Students will able to compare, select and analyse the right mode of heat transfer							

Experiment No.	**Experiment Title/Objective**	**Hours**
	1. Determination of thermal conductivity of insulating powder. 2. Determination of thermal conductivity of a given metal rod. 3. Determination of thermal conductivity of a given liquid. 4. Determination of thermal conductivity of composite slab. 5. Determination of heat Transfer Coefficient in Natural Convection from Cylinder. 6. Determination of heat Transfer Coefficient in Forced Convection from Cylinder. 7. Determination of Critical Heat Flux 8. Study of Performance of parallel and counter flow heat exchanger 9. Determination of emissivity of given surface 10. Determination of Stefan Boltzmann Constant. 11. Study and demonstration of heat pipe 12. Performance analysis of extended surfaces	

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PCC312							
Course Category	Professional Core Courses							
Course title	**Industrial Engineering and Management**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03	**–**	**–**	**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	70		–	–	–	–	100
Pre-requisites(if any)	In order to complete course study successfully, it is important to have a knowledge of manufacturing processes and industrial engineering.							
Course Objectives	1. To acquaint students with the basic concepts of industrial engineering and economics. 2. To impart understanding of motion study and work study 3. To integration of applications of industrial engineering in Job Evaluation and Merit Rating 4. To prepare for making decisions regarding money as capital within a technological or engineering environment. 5. To provide a sound understanding of concepts and principles of engineering economy							
Course Outcomes	1. Apply the basic concept and importance of industrial engineering and engineering economics 2. Perform method study and work measurement. 3. Apply the method of Break-even analysis and Make or buy decision to make cost effective decision 4. Apply various types methods for making rational decisions regarding problems							

Unit No.	**Course Content**	**Hours**
Unit 1	**Introduction to Industrial Engineering** Definition, Scope, Responsibilities, Important contributors to I.E., Tools and techniques of Industrial engineering, Plants Layout.	03
Unit II	**Motion study, Work study and measurement.** Motion Study- Process chart symbols, Outline and flow process charts, Flow diagrams, string diagram, flow process charts worker Material and equipment type, multiple activity chart – Man – Machine, Machine- Machine chart, Travel charts for workplace, Classification of movements, Two handed process chart, SIMO chart, Micro Motion study, Therbligs. Work Study- Definition, Objectives, Procedure, Time study equipment, Performance rating, Allowances, Concept of normal time and standard time, Calculation of standard time, Work sampling, Predetermined motion time analysis. (Case study on motion and work study)	11
Unit III	**Inventory Control.** Introduction, Type of Inventories, Reasons for Inventories, Objectives of inventory control, Benefits of Inventory control, Cost associated with inventory, Inventory control Technology, Inventory models, safety stock, inventory control systems.	5

Unit IV	**Job Evaluation and merits rating** Definition, Objectives, Procedure of job evaluation, Different incentive schemes and their advantages and disadvantages, Incentive schemes - Time, Piece, incentive systems, Halsey, Rowan, and Taylor's differential piece rate plan.	5
Unit V	**Basics of Engineering Economics.** Introduction to engineering economy, physical and economic environment, phases in engineering process, some economics concepts: value, utility, interest and interest rate, time value for money.	7
Unit VI	**Elements of costs.** Types of cost, Break even analysis, effects of fixed and variable cost on BEP, Economic order quantity, cost estimation method, make or buy decision, introduction to decision under risk criteria for: expected value and expected variance.	7

Important Note

Evaluation Pattern:

Assignments (CIE- 10 marks) – A minimum of 6 assignments will be given on the above course curriculum.

Text Books

1.	O.P. Khanna, Industrial Engineering and Management- Dhanpat Rai Publisher, 17th Edition 2017
2.	Martand Telsang, Industrial Engineering and Production Management, S. Chand Publisher, 3rd Edition 2018
3	M. I. Khan, Industrial Engineering, New Age International Publisher, 1st Edition 2004.
4	Engineering Economics, (Panneerselvam), PHI.

Reference Books

1.	Geneva Indian Adaptation International Labour Office, 'Work study' Publisher : Oxford & IBH Publishing Co Pvt.Ltd; 3rd Edition 2015
2.	Gavriel Salvendy, Handbook of Industrial Engineering: Technology & Operations Management, John Wiley & Sons; 3rd Edition 2007
3.	Engineering Economic Analysis, (Newnan, Eschenbach & Lavelle), Oxford University Press.
4.	Engineering Economy, (Blank & Tarquin), McGraw-Hill.

Useful web links

1.	https://www.isixsigma.com/topic/most-maynard-operation-sequence-technique/
2.	https://nptel.ac.in/courses/112/107/112107209/#
3.	https://www.nitie.edu/
4.	iiie-india.com/

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PCC313							
Course Category	Professional Core Courses							
Course title	**Machine Design II**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03	**—**	**—**	**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**—**	**—--**	**—-**	**—--**	**100**
Pre-requisites(if any)	Strength of Materials, Material Science and Machine Design I							
Course Objectives	1. To study design against fluctuating load. 2. To study bearing selection procedure. 3. To study design procedure of spur gear, helical gear, bevel gear, worm and worm wheel. 4. To understand tribological considerations of bearing design.							
Course Outcomes	1. Design of component for finite life and infinite life when subjected to fluctuating load. 2. Select bearings for a given applications from the manufacturers catalogue. 3. Design of elements like spur gears, helical gears, bevel gear, worm and worm wheel. 4. To study methods of lubrication and mounting of bearing.							

Unit No.	Course Content	Hours
1	Design against fluctuating load : Stress concentration, Causes and Remedies of Stress Concentration, Fluctuating Stresses, Fatigue Failure, Endurance limit, Notch sensitivity, Soderberg and Goodman diagram, Modified Goodman diagram, Fatigue design under combined stresses. (Note: The unit includes numerical treatment on the appropriate topics.)	07
2	Design of Sliding contact bearing: Basic Modes of Lubrication, Hydrostatic step bearing, and Reynolds's equation, Bearing design Selection of parameters, Bearing Constructions, Bearing Materials, Bearing Failure- causes and remedies. (Note: The unit includes numerical treatment on the appropriate topics.)	06
3	Design of Rolling contact bearing: Types, Static and dynamic load carrying capacity, Load-life relationship, Selection of bearing from manufactures catalogue, Comparison of sliding and rolling contact bearing, Mounting of bearings. (Note: The unit includes numerical treatment on the appropriate topics.)	06
4	Design of spur Gear: Force analysis, Gear tooth failures and remedies, Number of teeth, Face width, Beam strength of gear tooth, Wear strength of gear tooth, Effective load on gear tooth, Design of spur gears, (Note: The unit includes numerical treatment on the appropriate topics.)	07

5	Design of Helical gear: Terminology of Helical Gears, Virtual number of teeth, Tooth proportions, Force analysis, Beam strength of helical gears, Wear strength of helical gears, Effective load on gear tooth, Design of Bevel gears. (Note: The unit includes numerical treatment on the appropriate topics.)	07
6	Design of worm gear: Worm gear geometry and nomenclature, Force analysis, Strength rating of Worm Gears and Wear Rating of Worm gears, Worm gear thermal considerations, Design of Worm gears. (Note: The unit includes numerical treatment on the appropriate topics.)	06
Text Books		
1	Bhandari V.B. – "Design of Machine Elements" – Tata McGraw Hill Publ. Co. Ltd.	
2	Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Publ. Co. Ltd	
Reference Books		
1	Spotts M.F. and Shoup T.E. – "Design of Machine Elements" – Prentice Hall International.	
2	Black P.H. and O. Eugene Adams – "Machine Design" – McGraw Hill Book Co.Ltd.	
3	William C. Orthwein – "Machine Component Design" – West- publishing Co. and Jaico Publ.House.	
4	"Design Data" – P.S.G. College of Technology, Coimbatore.	
5	Juvinal R.C. – "Fundamentals of Machine Components Design" – John Wiley and Sons	
6	Hall A.S.; Holowenko A.R. and Laughlin H.G. – " Theory and Problems of Machine Design" Schaum's outline series	
Useful web link		
	https://archive.nptel.ac.in/courses/112/105/112105124/	

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PCC313							
Course Category	Professional Core Course							
Course title	**Machine Design –II (Lab)**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	—	**—---**	**01**	**02**		**01**		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**	
	—-	—---	50	—-	50	—-	100	
Pre-requisites(if any)	Strength of Materials, Material Science and Machine Design I							
Course Objectives	1.To study design of industrial mechanical systems consists of different types of gears. 2. To make conversant with preparation of working drawings. 3. Ability to solve different problems based on design of gears. 4. Ability to solve different problems based on selection of bearing and fluctuating loads.							
Course Outcomes	1.Prepare detailed design report on industrial mechanical systems consists of different types of gears. 2. Prepare working drawings of industrial mechanical system. 3. Solve problems on Spur gear, Helical gear, Bevel gear and worm gear. 4. Solve problems on fluctuating loads, rolling contact bearing and sliding contact bearing..							

Sr. No.	**Design Project/ Case Study/ Assignments**	**Hours**
1.	Total two design project A detail design report and A 2 Size sheet containing working drawing of details and assembly of project based on any relevant mechanical system consisting of i) Spur gear/ Helical gear. ii) Bevel gear / Worm and worm wheel.	04
2.	B) Assignments based on (Any four) i) Five problems on fluctuating loads. ii)Five Problems on Spur Gear Design iii)Five Problems on Design of Worm Gears iv) Study of Sliding contact Bearing and Rolling Contact Bearing. v) Composite assignment based on types of gears	08
	Text Books	
1.	Bhandari V.B. – “Design of Machine Elements” – Tata McGraw Hill Publ. Co. Ltd.	
2.	Shigley J.E. and Mischke C.R. – “Mechanical Engineering Design” McGraw Hill Publ. Co. Ltd.	
	Reference Books	
1.	Spotts M.F. and Shoup T.E. – “Design of Machine Elements” – Prentice Hall International.	

2.	Black P.H. and O. Eugene Adams – "Machine Design" - McGraw Hill Book Co. Ltd.
3.	William C. Orthwein – "Machine Component Design" – West- publishing Co. and Jaico Publ.House.
4.	"Design Data" – P.S.G. College of Technology, Coimbatore.
5.	Juvinal R.C. – "Fundamentals of Machine Components Design" – John Wiley and Sons
6.	Hall A.S.; Holowenko A.R. and Laughlin H.G. – " Theory and Problems of Machine Design" Schaum's outline series

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PCC314							
Course Category	Professional Core Courses							
Course title	**Dynamics of Machines**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03	**-**	**-**	**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**	
	30	70	-	-	-	-	100	
Pre-requisites(if any)	Kinematics of Machines, Strength of Machines							
Course Objectives	1. Introduce various types of clutches and brakes and dynamometers. 2. Introduce to the various types of governor and its working mechanisms. 3. Explain the phenomenon of gyroscope couple on aeroplane, naval ship and vehicles 4. To determine the static and dynamic forces for mechanical systems 5. Understand free and forced vibrations of single degree freedom systems 6. Explain the various type of damping and its characteristics							
Course Outcomes	1. Understand the difficulty of application of clutches and brakes in different working environment. 2. Identify, classify and choose the most appropriate type of dynamometer. 3. To classify the different governor mechanism and it application. 4. Formulate and solve different problems on gyroscopic couple. 5. To understand need of mechanical vibration in mechanical engineering. 6. Deploy skills effectively in the solution of damping problems in mechanical vibration.							

Unit No.	Course Content	Hours
	Unit I Friction Clutches, Brakes and Dynamometer Introduction, Types of clutch, uniform wear and Uniform pressure for the clutch, Types of brakes, effect of braking of a vehicle. Dynamometer: Absorption and transmission dynamometers, Study and analysis of absorption type dynamometer – Proney brake, Rope brake, dynamometers, Study and analysis of transmission type dynamometers.	6
	Unit II Governors	6

	Comparison between governors and flywheel, Typescentrifugal governors, inertia governors, Force analysis of gravity loaded governors– Watt, Porter, Proell, Force analysis of spring loaded governors Hartnell, hartung, Wilson Hartnell, Force analysis of spring and gravity loaded governor, Performance characteristics of governor stability, sensibility, isochronisms, Hunting, governor effort and governor power, coefficient of insensitiveness, introduction to MEMS based gyroscopes	
	Unit III Gyroscope Introduction- Gyroscopic couple and its effect on spinning bodies, Gyroscopic effect on naval ships during steering, pitching and rolling, Ship stabilization with gyroscopic effect. Two wheeler and four wheeler on curved path- effect of gyroscopic and centrifugal couples, maximum permissible speeds on curve paths, Gyroscopic effect due to lateral misalignment of rigid disc mounted on shaft.	6
	Unit IV Balancing: Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses rotating in same plane and in Different planes. Effect of Inertia Force due to Reciprocating Mass on Engine Frame, Partial balance of single cylinder engines. Primary and Secondary Balance of Multi-cylinder In-line Engines. Balancing of locomotive: variation of tractive force, swaying couple, and hammer blow. Direct and Reverse Crank method of balancing for radial engines. Balancing of V-engine. Balancing machines: Pivoted-Cradle Balancing Machine.	6
	Unit V: Introduction to Mechanical Vibration Basic concepts and definitions; vibration measuring parameters- displacement, velocity, and acceleration, Single degree of freedom system, SHM, Undamped free vibrations, damped free vibrations, Types of damping. Forced Vibration: Effect of excitation, Excitation due to reciprocating and rotating unbalance, Vibration isolation and transmissibility, Vibration sensors and IOT.	6
	Unit VI: Single Degree of Freedom Vibrating Systems 08 Viscous damped system-underdamped, critically damped, overdamped. Logarithmic decrement. Coulomb's damping. Combined viscous and coulomb's damping. Critical speed of shafts.	6
Text Books		
	Theory of Machines Ratan S.S Tata McGraw Hill New Delhi.	
	Theory of Machines P.L.Ballany Khanna Publication, New Delhi	
	Theory of Machines V.P. Singh Dhanpat Rai and Sons	
	Theory of machines Dr. R. K. Bansal Laxmi Publication	
Reference Books		
	Theory of Machines Thomas Bevan CBS Publishers, New Delhi.	
	Theory of Machines and Mechanism Shigley Oxford International	

	Theory of mechanism and machines Sadhu Singh Pearson
	Theory of machines and Mechanism Jagdish Lal Metropolitin Book Company
	Mechanism and Machines Gosh And Mallik East West Press
	Theory of Machine Sarkar Tata Mc Graw Hill
Useful web links	

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	ESC311							
Course Category	Engineering Science Courses							
Course title	**CAD/CAM/CAE**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Credits**		
	01	**-**	**02**	**03**		**02**		
Evaluation Scheme	**ISE**		**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	00		**00**	**50**	**00**	**50**	**00**	**100**
Pre-requisites(if any)	Laboratory work Engineering graphics, Machine drawing, Manufacturing Engineering I and II.							
Course Objectives	Understand the role of computers in design, analysis, and manufacturing. Learn geometric transformations, curve, surface, and solid modelling techniques. Gain knowledge of CNC machines and programming. Explore engineering analysis methods, including FEM and CAE tools.							
Course Outcomes	At the end of this course, student will able to Explain CAD, CAM, and CAE applications in manufacturing. Apply geometric transformations and solid modelling techniques. Demonstrate CNC machine programming and automation concepts. Utilize FEM and CAE tools for engineering analysis.							

Unit No.	**Course Content**	**Hours**
Unit I:	**Introduction:** Role of computers in design process; Computer aided design, analysis and manufacturing; Computer integrated manufacturing; Popular CAD software used in industry; Input and output devices.	02
Unit II:	**Transformations:** Matrix representation of points, lines and planes; 2D transformation for translation, scaling, rotation and reflection; Homogeneous representation & concatenation; 3D transformations.	02
Unit III:	**Curves and Surfaces:** Representation of curves; Hermite curves, Bezier curves, Bspline curves, Rational curves; Surface modelling – parametric representation, planar surface, surface of revolution, Coons and bicubic patches, Bezier and B-spline surfaces.	02
Unit IV:	**Solid Modelling:** Solid modelling techniques – sweep (linear and curved), Boolean (constructive solid geometry) and other techniques; Solid model representation (Boundary and Constructive Solid Geometry); Medical modelling (pixels, scans and voxels); Exchange standards (IGES, DXF, STEP, STL etc.).	02
Unit V:	**CNC Machine Tool:** Introduction, Principle of Numerical Control, Types of CNC Machine Tools, Features of CNC systems, Functions available in a typical CNC system, Standard controllers, Programming of CNC Machine Tools.	02
Unit VI:	**Engineering Analysis:** Introduction to finite element method; Principle of potential energy; FE analysis of 1D element problems (spring, bar, truss elements); Plain strain and plain stress problems; Popular CAE software used in industry.	02
Reference Books and web links		
1	**Text /Reference Books:**	

	Ibrahim Zeid, “Mastering CAD CAM,” Tata McGraw Hill Publishing Co. 2007. C. McMohan and J. Browne, “CAD/CAM Principles,” Pearson Education, 2nd Edition, 1999. Geometric Modeling, Michael E. Mortenson, Tata McGraw Hill, 2013. W. M. Neumann and R.F. Sproul, “Principles of Computer Graphics,” McGraw Hill, 1989. 5. D. Hearn and M.P. Baker, “Computer Graphics,” Prentice Hall Inc., 1992.
	Online Resources: **NPTEL Lecture Series:** • https://nptel.ac.in/courses/112/102/112102101/, • https://nptel.ac.in/courses/112/104/112104031/

Experiment No.	Experiment Title/Objective	Hours
1	Study of advanced machine tools.	
2	Study of numerical control programming for machines tools.	
3	Study of various software packages.	
4	Study of automation systems in manufacturing.	
5	Study of FMS	
6	Study of agile manufacturing	
7	Study of lean manufacturing systems	
8	Industrial visit.	
Reference Books and web links		
1	CAD/CAM, Principles and Applications –P N Rao, McGraw Hill, 2010	
2	CAD/CAM, Introduction, -Ibrahim Zeid, Tata McGraw Hill, 2007	
3	CAD/CAM, Introduction, -Ibrahim Zeid, Tata McGraw Hill, 2007	
4	Geometric Modeling, Michael E. Mortenson, Tata McGraw Hill, 2013.	

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PCC315							
Course Category	Professional Core course (Elective I)							
Course title	**Production & Operations Management**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03	**–**	**–**	**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	70		–	–	–	–	100
Pre-requisites(if any)								
Course Objectives	The Course is aimed to- 1. To provide knowledge on machines and related tools for manufacturing various components. 2. To understand the relationship between process and system in manufacturing domain. 3. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.							
Course Outcomes	At the end of this course students will demonstrate the ability to 1. To provide knowledge on production management techniques that develop and establish relationship between market demand and production capability. 2. To understand the operation management: Resource planning and their utility 3. To understand the scientific approach and tools and techniques that assure market competitiveness by ensuring the quality, cost and time							

Unit No.	Course Content	Hours
1	Introduction: Scope of production management. Production system and resources (machines, tooling, etc.); Types of production (batch, flow and unit), Roles of line supervisors and production managers.	07
2	Project Management: Project life cycle: concept phase (RFQ, Quotations, Proposals), Project initiations, DPR preparation (project value, business case development and feasibility study); Project planning (obtaining resources, acquiring financing and procuring required materials); Project team, producing quality outputs, handling risk, acceptance criteria; Project execution (allocation of resources, scheduling, building deliverables); Project Monitoring and control: Project networks, progress review (physical and financial), CPM and PERT, critical path, re-scheduling; Project closure: acceptance of project deliverable; Analytics: Performance, capability aggregation, cost benefit analysis, variability analysis, Output-outcome analysis, project documentation, best practices, and depository.	08

3	Production Planning and Control: Production planning, Process planning, Resource planning, demand-utility mapping (production capability index, forecasting models, aggregate production planning, materials requirement planning); Inventory Management: Economic order Quantity, discount models, stochastic inventory models, practical inventory control models, JIT; Supply chain and management.	07
4	Factory Management: Factory layout: line balancing, material flow and handling, Lean and green manufacturing, Human resource management, Training need analysis, Advantage and opportunities for Digitalization, Advanced factory systems: TQM; Important acts, regularities and safety norms, Reliability assessment of processes, Block chain, Energy management, Efficiency & throughput, Overall equipment effectiveness. Process capability, lean manufacturing.	07
5	Operation Management: Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment; Simple queuing theory models; Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model.	07

Important Note	
Text Books	
1	L.J. Krajewski and L.P Ritzmen, Operations Management: Strategy and Analysis, Pearson, 2010
2	R.B. Chase, F.R. Jacobs and N.J. Aquilano, Operations Management for Competitive Advantage, Tata McGraw Hill, 2011.
3	W. J. Hopp and M. L. Spearman, Factory Physics: Foundations of Manufacturing Management, McGraw Hill International Edition, 2008.
Reference Books	
1	Mahadevan. B., Operations Management: Theory and Practice, Pearson, 2015.
2	Taha H. A., Operations Research, 6th Edition, PHI India, 2003
3	M.P. Poonia, Total Quality Management, Khanna Publishing House, 2022.
Useful web links	
	https://onlinecourses.nptel.ac.in/noc20_mg06/preview

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PCC315							
Course Category	Professional Core course (Elective I)							
Course title	**Product Innovation & Entrepreneurship**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03	**–**	**–**	**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**–**	**–**	**–**	**–**	**100**
Pre-requisites(if any)	----							
Course Objectives	The Course is aimed to- To expose aspiring student entrepreneurs to various elements of a technology venture starting from market need identification to innovative solution development and its commercialization through business planning and start-up company incubation.							
Course Outcomes	At the end of this course students will demonstrate the ability to 1. Understand how to identify an unmet need through market research 2. Learn how to create an innovative solution and check problem-solution fit 3. Practice business planning, including marketing, fund-raising and start-up incubation.							

Unit No.	Course Content	Hours
1	Entrepreneurship: Role of entrepreneurship in economic development; Entrepreneurial mindset, motivation and competencies; Market pull and technology push factors; New product development lifecycle; Technology readiness levels; Product-market fit validation; Commercialization pathways; Business vision & leadership; Team composition & management.	08
2	Product Innovation: Opportunity scanning, market survey, need identification and problem definition; Creative design thinking for concept generation; Detailed design & prototyping;	07
3	Functionality & manufacturability; Bill of materials & components supply chain; Manufacturing & assembly plan; Product testing & quality assurance; Intellectual property rights management.	07
4	Marketing & Finance: Market segmentation & market sizing; Customer persona & value proposition; Marketing (Go-to-market) strategy; Distribution channels and sales network; Funding requirement (based on stage); Source of funding for startup ventures; Financial projections and accounting; Startup to scale up financing.	07
5	Venture Creation: Sustainable business options & pathways; Business model & business canvas; Startup team & business partners; Startup ecosystem and stakeholders; Technology business incubators & parks; Proposal pitching & agreements; Startup company incorporation; Social impact & responsibility	07

Important Note	
Course Project: Need identification, innovative solution, business plan, go-to-market strategy.	
Text Books	
1	Bill Aulet, “Technology Entrepreneurship”, 4th ed., Tata McGraw Hill, 2014.
2	Peter F. Drucker, “Innovation and Entrepreneurship”, 1st ed., Harper Business, 2006.
3	Chelat Bhuvanachandran, Innovision, Khanna Book Publishing, 2022.
Reference Books	
1	Byers, Dorf, and Nelson, Technology Ventures: From Ideas to Enterprise, McGraw Hill, 2010
2	Steve Blank, “The Startup Owner's Manual”
3	T.V. Rao, “Entrepreneurship - A South Asian Perspective”
Useful web links	
	https://onlinecourses.nptel.ac.in/noc22_ge03/preview

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PCC315							
Course Category	Professional Core course (Elective I)							
Course title	**Mechatronics and Robotics**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03	**–**	**–**	**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**–**	**–**	**–**	**–**	**100**
Pre-requisites(if any)								
Course Objectives	The Course is aimed to- 1. Model and analyze mechatronic systems for an engineering application 2. Identify sensors, transducers and actuators to monitor and control a process or product. 3. Develop PLC programs for an engineering application. 4. Evaluate the performance of mechatronic systems.							
Course Outcomes	At the end of this course students will demonstrate the ability to 1. Ability to recognize and analyze electro-mechanical systems in daily lives. 2. Understand the role of sensors, actuators, and controls in mechatronic systems. 3. Understand the basic theory of robot kinematics. 4. Familiarity with control theory and controller design.							

Unit No.	**Course Content**	**Hours**
1	Introduction: Electro-mechanical systems; Typical applications; Examples – automobiles, home appliances, medical instruments, etc.	06
2	Sensors: Transduction principles; Sensitivity, accuracy, range, resolution, noise sources; Sensors for common engineering measurements – proximity, force, velocity, temperature, etc.; Signal processing and conditioning; Selection of sensors.	06
3	Actuators: Pneumatic and hydraulic actuators; Electric motors including DC, AC, BLDC, servo and stepper motors; Solenoids and relays; Active materials – piezoelectric and shape memory alloys.	06
4	Machine Controls: Microprocessors and their architecture; Memory and peripheral interfacing; Programming; Microcontrollers; Programmable Logic Controllers; PLC principle and operation; Analog and digital input/output modules; Memory module; Timers, internal relays, counters and data handling; Industrial automation systems; Basic PLC programming; Industry kits (Arduino, Raspberry Pi, etc.).	06
5	Robotics: Robot configurations: serial and parallel; Denavit–Hartenberg parameters; Manipulators kinematics; Rotation matrix, Homogenous transformation matrix; Direct and	06

	inverse Kinematics for robot position and orientation; Workspace estimation and path planning; Robot vision; Motion tracking; Robot programming and control; Industrial robots - Pick and place robots, sorting, assembly, welding, inspection, etc.	
6	Computational Tools: Demonstration and projects using simulation software (e.g., Matlab, Scilab, ROBODK) for control systems and robotics.	06

Important Note	
Text Books	
1	W. Bolton, “Mechatronics,” Addison Wesley Longman, 2010.
2	J. J. Craig, Introduction to Robotics Mechanics and Control, Addison Wesley, 1999.
Reference Books	
1	G.K. McMillan, “Process/Industrial Instruments and Controls Handbook,” McGraw-Hill, 1999.
2	S. Mukherjee, “Essentials of Robotics Process Automation”, Khanna Book Publishing, 2021.
Useful web links	
	https://nptel.ac.in/courses/107/106/107106090/
	https://nptel.ac.in/courses/112/101/112101098/
	https://nptel.ac.in/courses/112/107/112107289/
	https://nptel.ac.in/courses/112/104/112104298/

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V						
Course Code	MDM 311/ EE-2						
Course Category	Multidisciplinary Minor Course II*						
Course title	**Energy Management**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**	
	03	**–**	**–**	**03**		**03**	
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**–**	**–**	**–**	**–**	**100**
Pre-requisites(if any)							
Course Objectives	The course is aimed at - 1. Model and analyze energy management systems for an engineering application 2. Identify different energy scenario based on economics for a process or product. 3. Develop energy management programs for an engineering application. 4. Evaluate the performance of energy management systems.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Ability to recognize and analyze energy management system in daily lives. 2. Understand the role of energy ecomonics in energy management systems. 3. Understand the basic theory of energy management. 4. Understand various computational techniques in energy management system.						

Unit No.	**Course Content**	**Hours**
1	Importance of energy management. Energy auditing :(methodology, analysis of past trends plant data),laws of thermodynamics, measurements, portable and on line measurements	06
2	Energy economics – Discount rate, payback period, internal rate of return, life cycle costing. Steam systems: Boiler – efficiency testing, steam distribution and use steam traps, condensate recovery, flash steam utilization. Thermal insulation	06
3	Electrical systems: Demand control, power factor correction, Motor drives- motor efficiency testing, energy efficient motors, motor speed control.Varaible speed drives. Lighting-lighting levels, fixtures, daylighting, timers, energy efficient windows	06
4	Energy conservation in pumps, Fans (flow control), compressed air systems, Refrigeration and air conditioning systems.Waste heat recovery: recuprators, heat wheels, heat pipes, heta pumps.	06

5	Cogeneration – concept, options (steam/ gas turbines/diesel engine based), selection criteria, control strategy	06
6	Computational Tools: Demonstration and projects using simulation software (e.g., Matlab, Scilab, ROBODK) for energy management.	06

Text Books	
1	Hand book on Energy Audit and Management, Amit kumar Tyagi, TERI Press
2	L.C.Witte, P.S.Schimdt, D.R.Brown, Industrial Energy Management and Utilisation, Hemisphere Publ,Washington, 1988.
3	Practical hand book on Energy Conservation in Buildings, Indian Building Congress, Nabhi Publication
4	The Efficient use of Energy, Ed: I.G.C.Dryden, Butterworths, London, 1982.
5	Energy Management Handbook, Ed: WQ.C.Turner, Wiley, New York, 1982.
Reference Books	
	Guide book for National Certification Examination for Energy Managers and Energy Auditors
	Energy Audit Professional by Dheungel
	Energy Management, Audit and Conservation (Kindle Edition) Barun Kumar De
Useful web links	
	https://nptel.ac.in/courses/112105221
	https://nptel.ac.in/courses/109106161

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	AEC311							
Course Category	Ability Enhancement Course							
Course title	**Introduction to Foreign Language**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	01	**–**	**–**	**01**		**01**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	-	**-**		**–**	**50**	**–**	**–**	**50**
Pre-requisites(if any)	HSMEC 111 , HSMEC 121							
Course Objectives	The Course Teacher will 1. Help students to understand basics and deepen their knowledge in a chosen foreign language. 2. Guide them to communicate and translate in the chosen foreign languages 3. Help them describe, narrate, and ask/answer questions in the foreign language in the present time about a variety of topics related to family, daily activities, eating, and traveling 4. Comprehend the foreign language with sufficient ability to grasp the main idea and some supporting details in short conversations (spontaneous or recorded) that pertain to the topics mentioned above 5. Explain how to write sentences and short paragraphs on familiar topics relating to personal interests and practical needs 6. Narrate on how the foreign language functions with awareness and understanding of the language culture							
Course Outcomes	Upon completion of this course, student should be able to 1. Learn alphabets, acquire knowledge of basic grammar of the foreign language, common words and phrases therein; 2. Learn to read the simple texts in foreign language; 3. Speak a little using the greetings, well wishes etc. in Foreign Language; 4. Count numbers, answer to the questions like, what is your name, surname, tell age, and can initiate little communication in Foreign Language; 5. Translate both verbally and written, simple sentences in the foreign language; 6. Achieve institute's mission with respect to global education and foreign language education.							

Unit No.	**Course Content**	**Hours**
1	General Information on Basic Grammar of the foreign language, Introduction to alphabets.	07
2	Gender of Noun, Number of Noun, Pronouns, Adjectives, Verbs and their usage in simple sentences, Numbers (up to 10), Simple Greetings in foreign language.	07
3	General Questions in foreign language, like What is your name/surname? Who/What is this? etc.	07
4	Simple narration about self/family/friend/University in foreign language chosen for studies. Practicing the learnt topics in the class itself.	05
5	Formation of simple sentences using Parts of Speech, Information on Cases, One or Two simple lessons from any book.	07

6	Basic information on Country & Culture of language under study.	06

Course Assessment Method

For the internal assessment of the course, with a total evaluation is of 50 marks. Combination of different evaluation methods can be utilized to ensure comprehensive assessment of the students' performance. The assessment will focus real-world scenarios that require the application of critical thinking, problem-solving, creativity, emotional intelligence, and teamwork. Following Evaluation Components are suggested:

1. Activity 1- Group Presentation (20 marks)

2. Activity 2- Group Discussion (20 marks)

3. Classroom Participation and Engagement (10 marks)
   Active participation in class discussions, group activities and question-answer sessions.

Studnts should write 6/8 questions on each Unit.

Reference Books

<table>
<tr><td>Year, Program, Semester</td><td colspan="5">Third Year B. Tech, (Mechanical Engineering) ,Semester V</td></tr>
<tr><td>Course Code</td><td colspan="5">MAC 312</td></tr>
<tr><td>Course Category</td><td colspan="5">Mandatory Audit Course</td></tr>
<tr><td>Course title</td><td colspan="5">Aptitude Enhancement Course II</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Total Contact Hours</td><td>Total Credits</td></tr>
<tr><td>-</td><td>01</td><td>-</td><td>01</td><td>-</td></tr>
<tr><td>Evaluation Scheme</td><td colspan="5">ISE at Course in charge end.</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="5">Basic Mathematical Concepts</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The Course is aimed to-
1. Understand key concepts such as HCF, LCM, decimal fractions, square roots, and cube roots, to build a strong base for problem-solving.
2. Enhance skills in simplifying complex mathematical expressions and perform efficient computations using the principles of simplification, surds, and logarithms.
3. Learn to solve practical problems involving percentages, profit-loss scenarios, and partnership calculations.
4. Grasp the principles and formulas used in solving problems related to time and work, pipes and cisterns, and time and distance.
5. Sharpen the ability to analyze and solve problems involving analogies, classifications, series, and coding-decoding sequences.
Develop problem-solving skills related to blood relations, direction sense tests, puzzles, and logical Venn diagrams.</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">Upon completion of this course, student should be able to –
1. Demonstrate an ability to solve problems related to number systems, including HCF, LCM, decimal fractions, square roots, and cube roots, accurately.
2. Solve complex problems involving simplification, surds, and logarithms more efficiently, and improve calculation speed and accuracy.
3. Apply knowledge of percentages, profit and loss, ratio and proportion, and partnership to real-life scenarios and mathematical problems.
4. Solve time, work, and distance-related problems, including pipes and cisterns, with a clear understanding of concepts and application of formulas.
5. Solve questions involving analogies, classifications, series completions, and coding-decoding with greater confidence.
Demonstrate enhanced ability to solve puzzles, directional sense, blood relation, and logical Venn diagram problems with precision and logical deduction.</td></tr>
</table>

Unit No.	Course Content	Hours
1	**Quantitative Aptitude 1** Number System, H.C.F. and L.C.M. of Numbers, Decimal Fractions, Simplification, square Roots and Cube Roots.	2
2	**Quantitative Aptitude 2** Average, Problems on Numbers, Problems on Ages, Surds and Indices, Logarithms.	2
3	**Quantitative Aptitude 3** Percentage, Profit and Loss, Ratio and Proportion, Partnership.	2
4	**Quantitative Aptitude 4** Chain Rule, Pipes and Cisterns, Time and Work, Time and Distance.	2
5	**Logical Reasoning 1** Analogy, classification, series completion, coding and decoding.	2
6	**Logical Reasoning 2** Blood relation, Puzzle test, direction sense test, logical Venn diagram.	2

General Instructions:
Each Student has to write at least 6 assignments on entire syllabus.

Reference Books

1. Dr. R S Aggarwal — Quantitative aptitude, S. Chand Publication.
2. R V Praveen — Quantitative aptitude and logical reasoning, 2nd Edition, PHI Publication.

Assessment

Assessment will be done by Course Teacher. MCQ Test can be conducted based on the syllabus.

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester V							
Course Code	PBL311							
Course Category	Project Based Learning							
Course title	**Mini Project III & Industrial Visit**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	–	**–**	**02**	**02**		**–**		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**	
	–	–	–	–	–	–	–	
Pre-requisites(if any)	Machine Tools and Processes, Tool Engineering, Machine drawing, Machine Design							
Course Objectives	The course is aimed at - 1. To understand the Product Development Process including budgeting through Mini Project. 2. To plan for various activities of the project and distribute the work amongst a team of two members. 3. To develop student's abilities to transmit technical information and test the same by working on Mini Project. 4. To learn and observe the actual industrial practices and after the visit students have to prepare the industrial visit report.							
Course Outcomes	Upon completion of this course, Students will be able to 1. Understand, plan and execute a Mini Project with the team. 2. Implement various manufacturing techniques, CAD learnt so far for designing and developing a prototype of a model. 3. Prepare a technical report based on the Mini project. 4. Students will be able to prepare the industrial visit report. 5. Deliver presentation on Mini Project work carried out.							

Unit No.	Course Content	Hours
1	Mini Project Completion and Assessment : 1. The purpose of the mini project is to promote self-study, innovative, creative thinking and independent research ability. Students have to initiate their own small conceptual or practical based projects individually as a team of no more than 2 members. While making this exercise it is expected that the knowledge acquired by them through application of subjects learnt so far is applied by them carrying out mini project work will certainly help the students for satisfactory and successful completion of their major project in the final year. 2. A mini project report is to be written upon completion of the activity. For team projects, each member has to write his own report. The report should include academic content such as the background, objectives, product/system description, the work done, the achievements and difficulties encountered. Students will deliver a report presentation and demonstration of their work. The assessment will be done by a mini project guide.	12

II	Industrial Visit 1) Industrial visits of the required subjects should be done. The purpose of Industrial visit is to learn and observe the actual industrial practices and after the visit students have to prepare the industrial visit report individually. The ultimate aim of industrial visit is to give more emphasis on: 1. Introduction of the Industry: Provide an overview of the industry being visited, including its history, significance. 2. Manufacturing Processes: Explore the various stages of production or manufacturing processes involved in the industry, including raw material sourcing, processing, assembly, quality control, and distribution. 3. Technology and Machinery: Examine the technology and machinery utilized in the industry, including any innovative equipment or automation techniques employed to enhance efficiency and productivity. 4. Plant Layout: Draw the detailed Plant layout of the industry representing various departments, production lines, labs, etc. 5. Health and Safety Practices: Discuss the health and safety regulations and practices implemented within the industry to ensure the well-being of workers and compliance with relevant standards. 6. Environmental Impact: Investigate the environmental impact of the industry's operations, including waste management practices, energy consumption, and efforts towards sustainability and eco-friendliness. 7. Supply Chain Management: Analyze the supply chain management practices within the industry, including procurement, logistics, inventory management, and transportation strategies. 8. Industry Challenges and Future Outlook. 2). An Industrial Report is to be written upon completion of the activity. Each member has to write his own report. The report should include all above mentioned points. The assessment will be done by mini project guide	--

Shivaji University, Kolhapur

Department of Technology

Third Year B. Tech (Mechanical Engineering), Semester-VI

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI							
Course Code	PCC 321							
Course Category	Professional Core Course							
Course title	**Control Engineering**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	3	**1**	**-**	**4**		**4**		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**	
	30	**70**	**–**	**-**	**-**	**-**	**100**	
Pre-requisites(if any)	strong foundational knowledge in differential equations, linear algebra, basic mechanics, and Laplace transforms from previous engineering courses							
Course Objectives	1. To Study the control system, its type and applications. 2. To prepare mathematical model of physical systems. 3. To Study concept of system stability and system response. 4. To Study various control actions.							
Course Outcomes	At the end of course student will able to 1. Understand control system, its type and applications. 2. Understand model of physical simple systems. 3. Determine system stability and system response. 4. Understand various control actions.							

Unit No.	Course Content	Hours
1	**Unit I: Introduction to Automatic Control** Generalized Control System Types, Open Loop and Closed Loop, Linear and Non-Linear, Time Variant and Time invariant Systems with examples. Advantages of Automatic Control Systems, Hydraulic/Pneumatic System, Hydraulic Servomotor, Jet – Pipe Amplifier, Pneumatic Amplifier. Thermal System, Gear Train. Merits of using Feedback control system,	06
2	**Unit II: Block Diagram Algebra and Mathematical Modeling** Rules for Reduction of Block Diagram, Control System Components – Tachometer, D.C. Servomotor , Stepper Motor, Mathematical Model of Control System: Mechanical Translational Systems, Rotational System, Grounded Chair Representation, Electrical Elements, Analogous Systems, Force – Voltage Analog, Force – Current Analog, Mathematical Model of Liquid Level System	06
3	**Transient Response:** General Form of Transfer Function, Concept of Poles and Zeros, Distinct, Repeated and Complex Zeros. Response of systems (First and Second Order) to Various Inputs (Impulse, Step, Ramp and Sinusoidal). Damping Ratio and Natural Frequency. Transient Response Specification	06

4	**Stability and Root Locus Technique:** Routh"s Stability Criteria, Significance of Root Locus, Construction of Root Loci, General Procedure, Effect of Poles and Zeros on the System Stability.	06
5	**State Space Analysis:** System Representation, Direct, Parallel, Series and General Programming, Conversion of State Space Model to Transfer Function, Basic Control Action and response of Control systems, Economic Inflation Problem, Pollution Control in Auto Engine, Control of blood pressure with anaesthesia,	06
6	**Frequency Response Analysis:** Frequency Response Log Magnitude Plots and Phase angle Plots, Gain Margin, Phase Margin, Evaluation of Gain „K", Polar Plots. System Compensation: Types of Compensators, Lead, Lag, Lead-Lag Compensators. (Note: The course numerical treatment on the appropriate topics of various units), Nyquist stability criterion	06

	Text Books
1.	Control System Engineering: R Anandnatarajan, P. Ramesh Babu, SciTech Publi
2.	Control Systems: A. Anand Kumar, Prentice Hall Publi.
3.	Automatic Control Engineering: F.H. Raven (5th ed.), Tata McGraw Hill Publi.
4.	I. J. Nagrath and M. Gopal, "Control System Engineering", 4 th Edition, New Age
5.	J. J. Distefano, III, A. R. Stubberud and I. J. Williams, "Feedback and Control Systems", 2 nd Edition, TMH, Schaums Outlines
	Reference Books
1.	Modern Control Systems: K Ogata, 3rd Ed, Prentice Hall Publi.
2.	B. C. Kuo and F. Golnaraghi, "Automatic Control Systems", 8 th Edition, John Wiley and Sons.
3.	Automatic Control Engineering: D. Roy and Choudhari, Orient Longman Publi Calcutta
4.	Modern Control Engineering K.Ogata Pearson Education
5.	G. F. Franklin, J. D. Powell, A. Emami, Naini, "Feedback Control of Dynamic Systems", 4 th Edition, Pearson Education.
6.	S. Ghosh, "Control Systems: Theory and Applications", 2nd Edition, Pearson.
7.	D. RoyChaudhury, "Modern Control Engineering", 4 th Edition, PHI
8.	SWAYAM COURSE: Control Engineering By Prof. Ramkrishna Pasumarthy | IIT Madras https://onlinecourses.nptel.ac.in/noc25_ee15/preview

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI						
Course Code	PCC 322						
Course Category	Professional Core Course						
Course title	**Metrology & Quality Control**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**	
	03	**-**	**-**	**03**		**03**	
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**	**-**	**-**	**-**	**-**	**100**
Pre-requisites(if any)	1. Metric and SI units of physical quantities. 2. Statistics. 3. Trigonometry and basics of manufacturing engineering.						
Course Objectives	1. To study methods and devices for measurement of linear, angle measuring instruments and comparators. 2. Understand the use of standards in measurement, limits, fits and tolerances. 3. Study the methods used for the measurement of screw threads and gears. 4. Study the measurement of geometrical forms and surface roughness and Advances in metrology. 5. To study quality control charts and Statistical tools.						
Course Outcomes	.At the end of course student will able to 1. Identify methods and devices for measurement of length, angle. 2. Discuss the basics of Limits, fits, tolerances and their role and importance in manufacturing. 3. Select proper measuring instrument for screw thread and gear measurement. 4. Learn advanced techniques of metrology in various industrial applications. 5. Understand Quality Control and Quality assurance concepts. 6. Analyze use of control charts and sampling plans.						

Unit No.	**Course Content**	**Hours**
I	Unit I: a) Measurements: International standards of length-Line and end measurement, Need of measurement, possible errors in measurement, slip gauges. b) Tolerances and gauging: Unilateral and bilateral tolerances, Limits, Fits, Types of Fits, IS specifications of limits. Importances of limits, System in mass production, limit gauges used for plain and taper works.	06
II	Unit II: a) Magnification : Principles and characteristics of measuring instruments, Mechanical, Optical, electrical, Pneumatic method of magnification, different types of Verniers, Micrometers, Dial gauges, Mechanical and pneumatic, Types of comparators. Use of comparators in inspection. b) Measurement of angles, tapers and radius : Bevel Protractor, Spirit level, Clinometers, angle Decker, standard balls and rollers for angle measurement, angle slip gauges, radius measurement of circular portion, measurement of concave and convex surface radius.	06

III	a) Interferometry: Principle of Interferometry and application in checking of flatness, angle and height. b) Straightness and Flatness: Straight edge, use of level beam comparator, autocollimator, testing of flatness of surface plate (Theoretical treatment only) and surface roughness.	06
IV	Surface finish measurement a) Surface finish: Types of textures obtained during machine operation, range of C.L.A. value in different operations in numerical assessment of surface finish (B.I.S. Specifications of C.L.A. value)-sample length of different machining operations. Direction of lay, texture, symbols, instruments used in surface finish assessment, Introduction & applications of: Coordinate Measuring Machine. b) Quality control: Concept of Quality and quality control, elements of quality and its growth, purpose, setup, policy and objective, factors controlling and quality of design and conformance, balance between cost and quality and value of quality. Specification of quality, planning through trial lots and for essential information.	06
V	a) Measurement of Spur Gears: Run out checking, Pitch measurement, profile checking, backlash checking, tooth thickness measurement, alignment checking, errors in gears, checking of composite errors. b) Measurement of External Threads: Different errors in screw threads, measurement of forms of thread with profile projector, pitch measurement, measurement of thread diameter with standard wire, screw thread micrometer.	06
VI	a) Statistical Quality Control: Importance of statistical method in quality control, measuring of statistical control variables and attributes. Measurement/inspection, different types of control charts(X Bars, R, P. charts) and their constructions and their application. b) Acceptance Sampling: Sampling inspection and percentage inspection, basic concept of sampling inspection, operating characteristic curves, conflicting interests of consumer and producer, producer and consumers risks, AWQL, LTPD, ADGL, single and double sampling plans. (Note: This course includes numerical treatment on the appropriate topics of various units.)	06

Text Books

1.	I. C. Gupta, “Engineering Metrology”, Dhanpat ana Rai Publications, New Delhi, India.
2.	M. S. Mahajan, “Statistical Quality Control”, Dhanpat and Rai Publications.

Reference Books

1.	R. K. Jain, “Engineering Metrology”, Khanna Publications, 17th edition, 1975.
2.	K. J. Hume, “Engineering Metrology”, McDonald Publications, 1st edition, 1950.
3.	A. W. Judge, “Engineering Precision Measurements”, Chapman and Hall, London, 1957.
4.	K. L. Narayana, “Engineering Metrology”, Scitech Publications, 2nd edition.
5.	J. F. Galyer, C. R. Shotbolt, “Metrology for Engineers”, Little-hampton Book Services Ltd., 5th edition, 1969.
6.	V. A. Kulkarni, A. K. Bewoor, “Metrology and Measurements”, Tata McGraw Hill Co. Ltd., 1st edition, 2009.
7.	Amitava Mitra, “Fundamental of Quality Control and Improvement”, Wiley Publication.
8.	V. A. Kulkarni, A. K. Bewoor, “Quality Control”, Wiley India Publication, 01st August, 2009.

9.	Richard S. Figliola, D. E. Beasley, “Theory and Design for Mechanical Measurements”, Wiley India Publication.
10	E. L. Grant, “Statistical Quality Control”, Tata McGraw Hill Publications.
Useful Web Links	
1.	**https://archive.nptel.ac.in/courses/112/104/112104250/**

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI							
Course Code	PCC 322							
Course Category	Professional Core Course							
Course title	**Metrology & Quality Control - Lab**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Credits**		
	-	**-**	**02**	**02**		**01**		
Evaluation Scheme	**ISE**		**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	-		**-**	**50**	**-**	**50**	**-**	**100**
Pre-requisites(if any)	None.							
Course Objectives	1.To Study the measurement using linear, angular, circular features, dimensional and geometric features. 2. To Analyze the surface roughness of components. 3.To Explain the importance of measurement of various parameters of screw threads, gears. 4. To Study statistical tools for analysis of quality.							
Course Outcomes	At the end of course, student will able to 1. Measure linear, angular, circular features, dimensional and geometric features. 2. Measure surface roughness of components. 3. Measure screw thread parameter and gear tooth parameter using appropriate instruments.. 4. Plot control charts for a given manufacturing process.							

Experiment No.	Experiment Title/Objective (Any Seven)	Hours
1.	Study and use of Vernier Caliper linear measuring Instrument	02
2.	Study and use of Micrometer linear measuring Instrument	02
3.	Study and use of Comparator	02
4.	Study and use of Angle Measuring instruments	02
5.	Screw Thread measurement	02
6.	Gear measurements and inspection.	02
7.	Use of Optical profile projector	02
8.	Study and use of Control charts	02
9.	Operating characteristics curves	02

General Instructions:

- Institutes Laboratory Course Manual and equipment-wise Standard Operating Procedure to follow.
- Conduct any seven experiments from the above.
- Batch-wise practical's are to be conducted. The number of students per batch should be as per the practical batches.
- Each Student has to write a practical journal.

<table>
<tr><td>Year, Program, Semester</td><td colspan="7">Third Year B. Tech (Mechanical Engineering) ,Semester VI</td></tr>
<tr><td>Course Code</td><td colspan="7">PCC 323</td></tr>
<tr><td>Course Category</td><td colspan="7">Professional Core Course</td></tr>
<tr><td>Course title</td><td colspan="7">Internal Combustion Engines</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Total Contact Hours</td><td colspan="3">Total Credits</td></tr>
<tr><td>3</td><td>—</td><td>—</td><td>3</td><td colspan="3">3</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td>ISE</td><td>ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td>30</td><td>70</td><td></td><td>—-</td><td>—-</td><td>—-</td><td>100</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="7">I Knowledge of Engineering Physics, Chemistry, Thermodynamics-I</td></tr>
<tr><td>Course Objectives</td><td colspan="7">1. To make the students familiar with the basics of thermodynamic cycles of I. C. engines.
2. To make the students understand about the combustion phenomenon of SI and C.I. engines.
3. To understand various I. C. Engine systems.
4. To understand engine testing and performance analysis.
5. To teach the students Production and utilization of alternative solid, liquid and gaseous fuels and engine pollutants.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">At the end of course, learners will able to

1. Explain thermodynamic cycles of I. C. Engines.
2. Explain fuel supply systems, combustion and emission aspects of I.C. Engines and recent developments in I.C. Engines.
3. Explain I. C. Engine systems and various components of Engines.
4. Explain performance parameters and characteristics; and calculation of performance parameters.
5. Interpret different alternative fuels and its emissions and method to control these emissions.</td></tr>
</table>

Unit No.	Course Content	Hours
1.	**Unit No I: Basic Concepts** Air standard cycles and fuel-air cycles Assumptions, Otto, Diesel & Dual cycles, comparison of cycles, fuel air cycle, Valve Timing diagram, Actual engine cycle.	6
2.	**Unit No- 2: S.I. Engines** Fuel Supply System, Theory of Carburetion, Electronic fuel injection system, GDI. Combustion in spark Ignition engines, stages of combustion, flame propagation, rate of pressure rise, abnormal combustion. Phenomenon of Detonation in SI engines, effect of engine variables on Detonation. Combustion chambers. Rating of fuels in SI engines. Additives.	6
3.	**Unit No- 3: C.I. Engines** Fuel supply system, types of fuel pump, injector and distribution system, combustion in compression ignition engines, stages of combustion, factors affecting combustion, Phenomenon of knocking in CI engine. Effect of knocking. Types of combustion chambers, rating of fuels in CI engines. Additives; Comparison of knocking in SI & CI engines, Concepts of Supercharging and Turbo charging.	6
4.	**Unit No- 4: Engine systems and components** Ignition system. (Battery, magneto & electronic), Lubrication system, Engine starting system Engine cooling system, Governing system, Intake and exhaust systems (two valves & fou valves)	6
5.	**Unit No-5: Performance characteristics & Testing of I.C. Engines** Introduction to Indian Standards for testing of I..C. Engine, Mean effective pressure, indicated power, brake power, friction power, Methods to determine power and efficiencies , Variables affecting performance of engine, characteristic curves, heat balance sheet, Methods of improving engine performance; super & turbocharged engines.	6
6.	**Unit No- 6: Fuels and Emissions** Chemical structure of the Petroleum, Refining process for petroleum, important qualities of the Engine fuels - (SI & CI engines), Diesel, and Gasoline fuels Indian specifications. Alternate fuels (SI & CI engines)- Liquid fuels, gaseous fuels, hydrogen engines, Air pollution due to IC engine, Engine emissions, Hydrocarbon emissions, (HC) & PPM & Carbon monoxide emissions (CO), oxides of Nitrogen (NOx) Euro norms, Bharat stage norms, Introduction to carbon credit, Emission control methods for SI and CI engines, Electronic control module, Catalytic converters, EGR Concept of hybrid vehicles.	6
	Suggested list of Tutorials and Assignments: Students should write One assignment on each topic. Each assignment should contain at least 6 questions. **General Instructions:** 1. Students must be encouraged to solve numerical problems. 2. Students must be encouraged to collect information about recent development in LC. Engines. 3. Students must be encouraged to read Magazines related to J.C. Engines.	

Text Books		
1.	V. Ganesan, "Internal Combustion Engines", Tata McGraw Hill, Second Edition.	
2.	Mathur and Sharma, "A Course in Internal Combustion Engines", R. P. Dhanapat Rai	
3.	Heywood, "LC. Engines Fundamentals", McGraw Hill Publication	
4.	R. K. Rajput, "Internal Combustion Engines", Laxmi publication, Delhi	
Reference Books		
1.	Dr. Kirpal Singh, "Automobile Engineering Vol. I and II", Standard Publishers	
2.	Edward E. Obert, "Internal Combustion Engines and Air Pollution", Internal Educational	
3.	Crouse W.H., "Automotive Mechanics", McGraw Hill Publication	
4.	Willard W. Pulkrabek, "Engineering Fundamentals of the Internal Combustion Engine.	
Useful web links		
1.	**https://onlinecourses.nptel.ac.in/noc25_me36**	
2.	**https://onlinecourses.nptel.ac.in/noc25_me19**	

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI						
Course Code	PCC 323						
Course Category	Professional Core Course						
Course title	**Internal Combustion Engines - Lab**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Credits**	
	—	**—**	**02**	**02**		**01**	
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	—	**—**	**50**	**—**	**50**	**—**	**100**
Pre-requisites(if any)	Knowledge of Engineering Physics, Chemistry, Thermodynamics-I						
Course Objectives	1. To describe the testing and performance characteristics of I. C. Engines 2.To Explain the parts and complete knowledge of types of fuels used in I. C Engine and the fuel supply systems. 3. To describe the combustion process phenomenon in I.C. Engines 4. To understand different tests and methods for performance analysis of I C Engines. 5. To explain the effects of emission and controlling techniques for I C Engines						
Course Outcomes	At the end of course, learners will able to I. Understand the complete operation of LC. Engines Find the performance of I C Engine and variation of various performance parameters with load and speed 2. Analyze the performance of the variable compression ratio engine with computerized set up 3. Analyze various Engines Systems and components. 4. Understand the emission formation of I.C. Engines, its effects and norms						

Experiment No.	Experiment Title/Objective	Hours
1.	Study & demonstration of Four stroke Petrol Engines.	02
2.	Study & demonstration of Four stroke Diesel Engines.	02
3.	Trial on Single Cylinder Diesel Engines.	02
4.	Morse Test on multi cylinder Petrol Engines.	02
5.	Study of combustion Phenomenon of SI & CI Engines.	02
6.	Trial on variable compression ratio Engines.	02
7.	Study and demonstration of various engine systems.	02
8.	Study of Alternative fuels.	02
9.	Study of Engine Emissions from SI and CI Engines.	02
10.	Visit to Engine or Engine Component Manufacturer or Engine Repairing Unit.	--

	General Instructions: ● Institutes Laboratory Course Manual and equipment-wise Standard Operating Procedure to follow. ● Conduct any eight experiments from the above. ● Batch-wise practical's are to be conducted. The number of students per batch should be as per the practical batches. ● Each Student has to write a practical journal.	

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI							
Course Code	OEC 321							
Course Category	Open Elective Course (Elective-I)							
Course title	**Operation Research**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03	**--**	**--**	**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**--**	**--**	**--**	**--**	**100**
Pre-requisites(if any)								
Course Objectives	The course aims to 1. To understand operation research principals. 2. To study the transportation and assignment model for industrial applications. 3. To understand Fundamentals of PERT/CPM Model. 4. Study of sequencing, replacement model, inventory model, decision theory and network analysis of industrial applications.							
Course Outcomes	Upon successful completion of this course, the student will be able to: 1. Formulate the problem by using operation research principals. 2. Evaluate problems of transportation and assignment model. 3. Analyze PERT/CPM models 4. Formulate and Analyze problems regarding sequencing, replacement model, inventory model, decision theory and network analysis of industrial application							

	Course Content	**Hours**
1	INTRODUCTION TO OPERATION RESEARCH Development of operations Research, characteristics and scope of operations Research, Models in operations Research, Model Formulation, Types of mathematical models, Limitations of operations Research. L.P. models, simplex method, the algebra of simplex method. (Minimization and Minimization problem) method, post optimality analysis, essence of duality theory, Application of sensitivity analysis.	06
2	TRANSPORTATION AND ASSIGNMENT MODELS Structure, industrial and business applications. a. Transportation problems Use of various methods for solving transportation problems, degeneracy and its solution. b. Assignment problems: Solution of various types of problems, Traveling Salesman problem.	06
3	FUNDAMENTALS OF CPM / PERT NETWORKS CPM – construction of networks, critical path, forward and backward pass, floats and their significance, crashing for minimum cost and optimum and minimum duration, resource allocation and leveling.	06

	PERT – Time Estimates, Construction of Networks, Probability of completing projects by given date.	
4	a. Sequencing: Sequencing of n jobs and 2 and 3 machines, 2 jobs and m machines. b. Replacement Analysis: With and without time value of money, single item and group replacement.	06
5	Inventory Models: Various costs involved, classification of models, EOQ model with and without shortage, EOQ with uniform demand and production lot size model, EOQ model with single price break.	06
6	Decision Theory: Pay off and regret tables, decision rules, decisions under uncertainty and risk, decision tree. Network Techniques: Shortest Path Model- Systematic Method, Dijkstra‟s Algorithm, Floyd‟s Algorithm	06

Text Books	
1	“Operation Research an Introduction”, Hamdy A. Taha, Pearson, 9th Edition.
2	“Operations Research”, J. K. Sharma, McMillan India Publication New Delhi, 5th Edition
3	“Operations Research”, Hira and Gupta, S.Chand and Co. New Delhi.
4	“Operations Research”, Manohar Mahajan Dhanapat Rai and Sons.
Reference Books	
1	“Operation Research”, Pradeep J. Jha, Tata McGraw Hill Publication
2	“Introduction to Operation Research”, Paneer-Selvam, Prentice Hall of India publication, 2nd Edition.
3	“Production and Operation Management”, Tripathy, Scitech Publication, 2nd Edition.

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI						
Course Code	OEC 321						
Course Category	Open Elective Course (Elective-I)						
Course title	**Reliability Engineering**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**		
	03			**03**	**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**---**	**---**	**---**	**---**	**100**
Pre-requisites(if any)							
Course Objectives	The course aims to 1. Understand and familiarize with concept of reliability and maintainability. 2. Understand how to analyze a system for reliability assessment and life cycle costing. 3. Familiarize with condition monitoring in maintainability. 4. Understand the importance and application of reliability in designing and maintenance of product.						
Course Outcomes	Upon successful completion of this course, the student will be able to: 1. Formulate the problem by using reliability and maintainability principles. 2. Evaluate life cycle of a product and life cycle costing. 3. Analyze Techno-economic life of component/product. 4. Formulate, evaluate and model the problems regarding availability and reliability of perticular engineering applications such as civil structure, electronic components, computer networks, mechanical machines and food processing.						

UNIT NO.	**Course Content**	**Hours**
1	**Reliability** Introduction to Reliabnility, Definition -methods of improving reliability, derivation of Reliability function, configurations of reliability, series parallel & mixed configuration, simple problems	06
2	**Reliability Calculations** Methods of improving reliability, redundancy element, unit stand-by redundancy, reliability models, constant hazard, simple problems, hazard models.	06
3	**Maintenance Systems** Objective, of maintenance, maintainability and availability concepts, types of availability - mean time to failure-mean time between failures-mean time to repair-mean down time-Reliability allocation	06
4	**Life Cycle Costing** Techno economic Life; Reliability effort function, simple cost models for Life cycle.	06
5	**Maintenance Management** Principles types of maintenance breakdown, periodic, preventive and total productive maintenance etc.	06

6	**Failure analysis techniques** Root cause analysis, Fault tree analysis, Fishbone diagram, Failure mode and effects analysis (FMEA), FMECA.	06

1	"Reliability Engineering", L. S. Srinath, Fourth Edition Affiliated East -West Press, Reprint 2009.
2	"Terotechnology: Reliability Engg & maintenance Management",S.K. Basu & B.Bhadury, Asian book Private Ltd., Delhi, 1stEdition, 2003.
3	"Reliability Engineering and Risk Analysis: A practical guide", Mohammad Modarres, Mark P. Kaminskiy, Vasiliy Krivtsov , 3rd edition, Publisher: CRC Press, 2016.
4	"An Introduction to Reliability and Maintainability Engineering", Charles E. Ebeling, 3rd edition, Publisher: McGraw Hill Education, 2019.
Reference Books	
1	"Engineering Reliability-New Techniques and Applications", C. Singh and C.S. Dhillon, –John Wiley and Sons.
2	"Industrial management and Organizational Behaviour",K. K. Ahuja,, Khanna Publications. 1999
3	"Industrial engineering Management", Dr. Shankar, Golgotia Publications Pvt. Ltd. 1997.
Useful web links	
	https://onlinecourses.nptel.ac.in/noc23_ge20/preview

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI							
Course Code	EEC 321							
Course Category	Program Elective Course (Elective-II)							
Course title	**Finite Element Analysis**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03			**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**---**	**---**	**---**	**---**	**100**
Pre-requisites(if any)								
Course Objectives	The course is aimed at - 1. To illustrate the principle of mathematical modeling of engineering problems 2. To introduce the basics and application of Finite Element Method							
Course Outcomes	Upon completion of the course, students will understand the FEM formulation and its application to simple structural and thermal problems							

Unit No.	**Course Content**	**Hours**
1	Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method.	09
2	One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer, longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and natural frequencies.	09
3	Two dimensional equations, variational formulation, finite element formulation, triangular elements shape functions, elemental matrices and RHS vectors; application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.	09
4	Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software.	09

Text Books	
1	Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005
2	Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007
3	Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann, 2004.
4	
Reference Books	
1	Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall, 1990.
Useful web links	

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI							
Course Code	PEC 321							
Course Category	Program Elective Course (Elective-II)							
Course title	**Power Plant Engineering**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03			**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**---**	**---**	**---**	**---**	**100**
Pre-requisites(if any)								
Course Objectives	The course aims to 1. Understand the different power generation methods, its economics and global energy situation 2. Familiarize with Equipment, Plant layout, principle of working of various Steam turbine, gas turbine and diesel power plants. 3. Interpret the working principles of various nuclear reactors. 4. Understand the types and capacity calculation of Hydroelectric Power Plant. 5. Understand Non- Convectional Power Plants and its commercialization. 6. Understand Economic analysis and environmental impact of Power Plants.							
Course Outcomes	Upon successful completion of this course, the student will be able to: 1. Explain the energy resources and energy systems available for the production of electric power in the India and the world. 2. Explain construction and working of steam power plants, Gas turbine power plant, Diesel power plant 3. Explain the basic principles of nuclear power plants, 4. Explain hydroelectric power plant, major types of Non- conventional power plants and estimate power generation potential. 5. Discuss economic analysis and the environmental impact of electric power production on air quality, climate change, water, and land.							

	Course Content	**Hours**
1	INTRODUCTION OF POWER PLANT: Introduction: Resources and development of power in India, NTPC, NHPC and their role in Power development in India, Present Power position in India and Maharashtra. Power Plants Introduction, Factors affecting Selection and relative merits of steam, Gas, Diesel, Hydro Power Plants	06
2	STEAM AND GAS TURBINE POWER PLANT: Steam turbine power plant Introduction, general layout of steam power plant, necessity of feed water treatment, high pressure boilers and importance of water purity, effect of operating variable on thermal efficiency, regeneration, reheating, Cogeneration power Plant Gas turbine power plant Introduction, general layout of gas turbine power plant, effect of operating variable on thermal efficiency, regeneration, reheating, and performance of closed and semi closed cycle gas turbine plant.	06

3	NUCLEAR AND DIESEL POWER PLANT: Nuclear power plant: Elements of nuclear power plant, Nuclear reactors and its types, fuel moderators, coolants, control rod, classification of nuclear power plants, waste disposal. Diesel Power Plant: Field of Use, Plant Layout, Different systems of Diesel Power Plant, application, advantages and disadvantages of diesel power plant	06
4	HYDROELECTRIC POWER PLANT: Hydroelectric Power Plant (HPP): site selection, classification of HPP, and their field of use, capacity calculation for hydro power, dam, head water control, penstock, water turbines, specific speeds, governors, hydroelectric plant auxiliaries, plant layout, automatic and pumped storage, project cost of hydroelectric plant. Advantages and limitations of hydro power plant.	06
5	NON- CONVENTIONAL POWER PLANTS: Wind Power plant: Introduction, wind availability measurement, types of wind machines, site selection, and wind power generation. Solar Power Plant: Introduction, components ,Types of Collectors and Solar Ponds, Low and High Temperature Solar Power Plant. Photovoltaic Power System, Heliostat Tidal, OTEC, geothermal, magneto hydrodynamics, fuel cell, hybrid power plants, Challenges in commercialization of Non-Conventional Power Plants.	06
6	ECONOMIC ANALYSIS AND ENVIRONMENTAL IMPACT: Cost of energy production, selection of plant and generating equipment, performance and operating characteristics of power plants, tariffs for electrical energy. Environmental Impact due to Power Plant: Introduction, Different pollutants due to thermal power plant and their effect on human health, Global warming and greenhouse effect, thermal Pollution of water and its control.	06

Text Books	
1	Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2	El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010
3	"Power Plant Engineering" Domkundwar and Arora, Dhanpat Rai and Sons, New Delhi
4	
Reference Books	
1	Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

2	“Non-conventional energy sources” G. D. Rai
Useful web links	
1	https://onlinecourses.nptel.ac.in/noc22_me73/preview

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI							
Course Code	EEC 321							
Course Category	Program Elective Course (Elective-II)							
Course title	**Additive Manufacturing**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03			**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**---**	**---**	**---**	**---**	**100**
Pre-requisites(if any)								
Course Objectives	To provide an overview of Additive Manufacturing processes, systems and applications.							
Course Outcomes	At the end of this course students will demonstrate the ability to 1. Understand the overall principle and various processes for additive manufacturing. 2. Select a particular additive manufacturing process based on the end application. 3. Plan the steps in fabricating a given part using additive manufacturing.							

	Course Content	**Hours**
1	**Introduction to Additive Manufacturing (AM)**: Evolution of AM/3D printing; Comparison with subtractive and forming processes; Advantages of AM; Classification of AM processes; Key steps in AM.	07
2	**Liquid State-based AM Processes**: Stereo lithography – Process and working principle; Photopolymers; Photo polymerization, layering technology, Laser and Laser scanning; Micro-stereolithography; Equipment and specifications; Applications, advantages, disadvantages, examples; Solid ground curing: Process, Working principle; Equipment and specifications; Applications, advantages, disadvantages, examples	07
3	**Solid State-based AM Processes**: Fused Deposition Modeling – Process, working principle and materials; Equipment and specifications; Laminated object manufacturing – Process and working principle; Equipment and specifications; Applications, advantages, disadvantages, examples; Other solid-state processes – Ultrasonic consolidation, Gluing, Thermal bonding; Demonstration of equipment	07
4	**Powder Based AM Processes**: Powder Bed Fusion Processes – Working principle and materials; Powder fusion mechanism and powder handling; Various LBF processes (principle, materials, applications and examples) – Selective laser Sintering, Electron Beam Melting, Laser Engineered Net Shaping, Binder Jetting and Direct Metal Deposition; Comparison between LBF processes; Materials-process-structure-property relationships; relative advantages and limitations	08

5	**Applications of AM: Product development lifecycle applications –** Rapid prototyping, concept models, visualization aids, replacement parts, tooling, jigs and fixtures, moulds and casting; Application sectors – aerospace, automobile, medical, jewelry, sports, electronics, food, architecture, construction and others.	07

Text Books	
1	Sabrie Soloman, 3D Printing & Design, Khanna Book Publishing Company, New Delhi, 2020
2	Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing", Springer, 2015
Reference Books	
1	Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications," World Scientific, 2015.
2	C.P Paul, A.N Junoop, "Additive Manufacturing: Principles, Technologies and Applications," McGrawHill, 2021.
Useful web links	
1	https://onlinecourses.nptel.ac.in/noc21_me115/preview
2	https://onlinecourses.nptel.ac.in/noc20_mg70/preview

Year, Program, Semester	Third Year B. Tech (Mechanical Engineering) ,Semester VI							
Course Code	MDM 321/ EE-3							
Course Category	Multidisciplinary Minor Course III*							
Course title	**Solar Thermal Power Engineering**							
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**		
	03	**–**	**–**	**03**		**03**		
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	**70**		**–**	**–**	**–**	**–**	**100**
Pre-requisites(if any)								
Course Objectives	The course is aimed at - 1. Model and analyze solar thermal power energy systems for an engineering application 2. Identify different energy resource and solar spectrum. 3. Evaluate the performance of solar thermal energy systems.							
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of solar thermal power plant . 2. Design an application of solar thermal power plant. 3. Understand the working of solar thermal power plant. 4. Understand conversion system of solar thermal power plant.							

	Course Content	**Hours**
1	Energy Resources And Solar Spectrum World energy resources - Indian energy scenario - Environmental aspects of energy utilization. Renewable energy resources and their importance - Global solar resources. Solar spectrum – Electromagnetic spectrum, basic laws of radiation. Physics of the Sun - Energy balance of the earth, energy flux, solar constant for earth, green house effect.	6
2	Solar Radiation And Measurement Solar radiation on the earth surface - Extraterrestrial radiation characteristics, Terrestrial radiation, solar insolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation – Pyranometer, Pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E).	6
3	Solar Radiation Geometry And Calculations Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence – Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length – Sun path diagram – Shadow determination. Estimation of Sunshine hours at different places in India. Calculation of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability	6
4	Solar Thermal Energy Conversion Thermodynamic cycles – Carnot – Organic, reheat, regeneration and supercritical Rankine cycles – Brayton cycle – Stirling cycle – Binary cycles – Combined cycles. Solar thermal power plants - Parabolic trough system, distributed collector, hybrid solar-gas power plants, solar pond based electricpower plant, central tower receiver power plant.	6

5	Solar Electrical Energy Conversion Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.	6
6	Examples and Case Studies:	6

Text Books	
1	Foster .R, Ghassemi M., Cota A., “Solar Energy”, CRC Press, 2010.
2	Duffie .J.A, Beckman W.A. “Solar Engineering of Thermal Processes”, 3rd ed., Wiley, 2006.
3	De Vos .A, “Thermodynamics of Solar Energy Conversion”, Wiley-VCH, 2008.
4	Garg .H.P, Prakash .J, “Solar Energy Fundamentals and Applications”,
Reference Books	
	Kreith F. and Kreider J.F., “Principles of Solar Engineering”, McGraw-Hill, 1978.
	Fundamentals of solar energy conversion: by E.E. Anderson.
Useful web links	
	https://nptel.ac.in/courses/115103123
	https://archive.nptel.ac.in/courses/112/105/112105051/

Year, Program, Semester	Third Year B. Tech, (Mechanical Engineering) ,Semester VI							
Course Code	AEC321							
Course Category	Ability Enhancement Courses							
Course title	**Mini Project IV & Industrial Visit**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
	02	**–**	**-**	**02**		**02**		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total	
	--	**--**	**---**	**50**	**--**	**50**	**100**	
Pre-requisites(if any)	Machine Tools and Processes, Tool Engineering, Machine drawing, Machine Design.							
Course Objectives	The course is aimed at - 1. To understand the Product Development Process including budgeting through Mini Project. 2. To plan for various activities of the project and distribute the work amongst a team of two members. 3. To develop student's abilities to transmit technical information and test the same by working on Mini Project. 4. To learn and observe the actual industrial practices and after the visit students have to prepare the industrial visit report.							
Course Outcomes	Upon completion of this course, Students will be able to 1. Understand, plan and execute a Mini Project with the team. 2. Implement various manufacturing techniques, CAD learnt so far for designing and developing a prototype of a model. 3. Prepare a technical report based on the Mini project. 4. Students will be able to prepare the industrial visit report. 5. Deliver presentation on Mini Project work carried out.							

Unit No.	Course Content	Hours
I	1. Mini Project Completion and Assessment : 1. The purpose of the mini project is to promote self-study, innovative, creative thinking and independent research ability. Students have to initiate their own small conceptual or practical based projects individually as a team of no more than 2 members. While making this exercise it is expected that the knowledge acquired by them through application of subjects learnt so far is applied by them carrying out mini project work will certainly help the students for satisfactory and successful completion of their major project in the final year. 2. A mini project report is to be written upon completion of the activity. For team projects, each member has to write his own report. The report should include academic content such as the background, objectives, product/system description, the work done, the achievements and difficulties encountered. Students will deliver a report presentation and demonstration of their work. The assessment will be done by a mini project guide.	12

II	Industrial Visit 1) Industrial visits of the required subjects should be done. The purpose of Industrial visit is to learn and observe the actual industrial practices and after the visit students have to prepare the industrial visit report individually. The ultimate aim of industrial visit is to give more emphasis on: 9. Introduction of the Industry: Provide an overview of the industry being visited, including its history, significance. 10. Manufacturing Processes: Explore the various stages of production or manufacturing processes involved in the industry, including raw material sourcing, processing, assembly, quality control, and distribution. 11. Technology and Machinery: Examine the technology and machinery utilized in the industry, including any innovative equipment or automation techniques employed to enhance efficiency and productivity. 12. Plant Layout: Draw the detailed Plant layout of the industry representing various departments, production lines, labs, etc. 13. Health and Safety Practices: Discuss the health and safety regulations and practices implemented within the industry to ensure the well-being of workers and compliance with relevant standards. 14. Environmental Impact: Investigate the environmental impact of the industry's operations, including waste management practices, energy consumption, and efforts towards sustainability and eco-friendliness. 15. Supply Chain Management: Analyze the supply chain management practices within the industry, including procurement, logistics, inventory management, and transportation strategies. 16. Industry Challenges and Future Outlook. 2). An Industrial Report is to be written upon completion of the activity. Each member has to write his own report. The report should include all above mentioned points. The assessment will be done by mini project guide	--

<table>
<tr><td>Year, Program, Semester</td><td colspan="5">Third Year B. Tech, (Mechanical Engineering) ,Semester VI</td></tr>
<tr><td>Course Code</td><td colspan="5">MAC 322</td></tr>
<tr><td>Course Category</td><td colspan="5">Mandatory Audit Course</td></tr>
<tr><td>Course title</td><td colspan="5">Aptitude Enhancement Course III</td></tr>
<tr><td rowspan="3">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Total Contact Hours</td><td>Total Credits</td></tr>
<tr><td>--</td><td>01</td><td>--</td><td>01</td><td>---</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Evaluation Scheme</td><td colspan="5">ISE at Course in Charge end</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="5">Basic Mathematical Concepts</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The Course is aimed to-
1. Equip students with techniques for solving quantitative aptitude problems like interest and mixture.
2. Enhance logical reasoning abilities, including decision-making and assertion-reason analysis.
3. Develop skills to calculate and apply geometric areas, volumes, and surface areas in problem-solving.
4. Introduce fundamental concepts of probability and statistics for solving quantitative problems.
5. Strengthen abilities to solve time-based problems, improving speed and accuracy.
Train students to recognize and solve logical sequences and patterns in reasoning and mathematics.</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">Upon completion of this course, student should be able to –
1. Solve quantitative aptitude problems related to Boats and Streams, Trains, Mixtures, and Interest calculations effectively.
2. Develop logical reasoning skills for problems like decision-making, number ranking, and time sequence tests.
3. Calculate areas, volumes, and surface areas of geometric shapes and apply them to practical problems.
4. Apply probability and statistical analysis in solving real-world problems like stocks, shares, and series.
5. Solve time-based problems involving calendars, clocks, and distances, enhancing time management skills.
Master advanced techniques in Permutations, Combinations, and other mathematical concepts for higher-level exams.</td></tr>
</table>

Unit No.	Course Content	Hours
1	**Quantitative Aptitude 1** Boats and Streams, Problems on Trains, Alligation or Mixture, Simple Interest.	2
2	**Quantitative Aptitude 2** Compound Interest, Area, Volume and Surface Area, Races and Games of Skill.	2
3	**Quantitative Aptitude 3** Calendar, Clocks, Stocks and Shares, Permutations and Combinations.	2
4	**Quantitative Aptitude 4** Probability, True Discount, Banker's Discount, Heights and Distances, Odd Man Out and Series.	2
5	**Logical Reasoning 1** Number ranking and time sequence test, Decision making, Assertion and reason, Situation reaction Test.	2
6	**Logical Reasoning 2** Mathematical Operations, Inserting the missing one, logical sequence of words.	2

General Instructions:

Each Student has to write at least 6 assignments on entire syllabus.

Reference Books

1. Dr. R S Aggarwal — Quantitative aptitude, S. Chand Publication.
2. R V Praveen — Quantitative aptitude and logical reasoning, 2nd Edition, PHI Publication.

Assessment

Assessment will be done by Course Teacher. MCQ Test can be conducted based on the syllabus.

Year, Program, Semester	Third Year B. Tech, (Mechanical Engineering) ,Semester VI				
Course Code	PBL321				
Course Category	Mandatory Audit Course				
Course title	Design Thinking & Innovation – III				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	--	--	02	02	----
Evaluation Scheme	ISE at Course in Charge end				
Pre-requisites(if any)	VSEC111, VSEC121				
Course Objectives	The Course is aimed - 1. To advance students' capabilities in synthesizing complex design challenges into feasible solutions. 2. To refine iterative problem-solving skills through industry-focused projects and case studies. 3. To cultivate a proactive, entrepreneurial mindset that addresses sustainability and societal needs				
Course Outcomes	Upon completion of this course, student should be able to 1. Analyze complex problems to develop innovative, user-centric design solutions. 2. Apply advanced prototyping techniques to validate and optimize product concepts. 3. Collaborate effectively across disciplines to deliver actionable and sustainable innovations.				

Unit No.	Course Content	Hours
1	**Design Thinking Framework Revisited** : Advanced principles of empathy, ideation, and prototyping, Reflection on learning from Design Thinking & Innovation I and II, Introduction to systems thinking in the design context	04
2	**Problem Scoping and Opportunity Identification:** Techniques for problem discovery and framing, Identifying gaps and opportunities in existing systems, Leveraging tools like Journey Mapping and SWOT Analysis	04
3	**Ideation Techniques and Advanced Prototyping:** Brainstorming: Mind Mapping and SCAMPER techniques, Prototyping with a focus on technology integration, Real-world prototyping examples from diverse industries.	04
4	**Validation and Iterative Development:** Usability testing methods and feedback incorporation, Iterative designs models: Agile and Lean principles, Creating Minimum Viable Products (MVPs).	04
5	**Innovation Strategy and Entrepreneurship:** Bridging design with business models (Canvas Model), Strategies for market positioning and scaling innovations, Ethical considerations and sustainable innovation practices	04
6	**Case Studies and Capstone Projects:** Real-world applications of design thinking in Chemical Engineering, Group projects focusing on an innovative solution for an industry-related problem, Presentation and feedback.	04
	Text Books	
1.	Brown, T. (2--9). Change by Design. Harper Business.	
2.	Lewrick, M., Link, P., & Leifer, L. (2-18). The Design Thinking Playbook. Wiley	

Reference Books	
1.	Plattner, H., Meinel, C., &Leifer, L. (2-2-). Design Thinking Research. Springer.
2.	Christensen, C. M. (2-13). The Innovator's Dilemma. Harvard Business Review Press

Equivalence for the curriculum revision at B.Tech Mechanical Engineering

We at the B.Tech Mechanical Engineering, Department of Technology due for revision in curriculum w.e.f. 2023-2024 have revised the structure and the content as well at the F. Y. B. Tech Mechanical Engineering. The entire structure for **Third Year Final Year B. Tech (Mechanical Engineering)** is also designed under this revision. The detailed of course content will be designed and submitted as the First Year batch proceed year to year.

A special mention rather feature of this revision is, ***it is in line with New National Education Policy 2020 guidelines.*** It is our every effort to incorporate most of the key features of NEP2020.

Following is a semester wise table that depicts equivalences for the previous version of curriculum with the new one.

SEMESTER – V

Sr. No.	Third Year B. Tech Semester V Pre-revised syllabus	Third Year B. Tech Semester V Revised syllabus	Remark
1.	Machine Design I	Machine Design II	Machine Design I shifted to IV semester. Machine Design II shifted from Semester VI with Content revision.
2.	Theory of Machines II	Dynamics of Machines	Title change with content revision
3.	Energy Engineering		Shift to Electives
4.	Tool Engineering	Industrial Engineering and Management	Title change with content revision
5.	Heat and Mass Transfer	Heat and Mass Transfer	Content revision.
6.		Elective I	Newly introduced.
7.	Laboratory Computer Aided Drafting	CAD/CAM/CAE	Title change with content revision
8.	Internship I	-	Newly introduced.
9.	Introduction to Foreign Language	Introduction to Foreign Language	Content revision.
10.	-	Aptitude Enhancement Course II	Newly introduced.
11.	-	Mini Project III & Industrial Visit (Lab)	Newly introduced.

SEMESTER – VI

Sr. No.	Third Year B. Tech Semester VI Pre-revised syllabus	Third Year B. Tech Semester VI Revised syllabus	Remark
1.	Control Engineering	Control Engineering	Content revision
2.	Metrology and Quality Control	Metrology and Quality Control	Content revision
3.	Internal Combustion Engines	Internal Combustion Engines	Content revision
4.		Power Plant Engineering	Shifted from VIIIth Semester
5.		Open Elective –I	Newly added.
6.		Elective –II	Newly added.
7.	Machine Design II	-	Shifted to previous semester
8.	Engineering Economics	-	Clubbed with Industrial Engineering and Management
9.	-	Industrial Safety, Health & Hazard Management (Tutorial)	Newly introduced.
10.	-	Design Thinking & Innovation – III (Theory)	Newly introduced.
11.	-	Aptitude Enhancement Course III	Newly introduced.