NAGARJUNA
COLLEGE OF ENGINEERING & TECHNOLOGY

An Autonomous College under VTU

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To train the students as professionals in Mechanical Engineering blended with leadership qualities to achieve excellence in the challenging future.

MISSION

M1: Maintaining excellence in Mechanical Engineering education through academic professionalism and teaching for the changing needs of the society.

M2: EstablishingCentreofexcellenceforresearchtopromoteindustrialexposure in the area of Mechanical Engineering.

M3: Developing communication skill, leadership qualities, team work and skills for continuing education among the students

M4: Inculcating ethics, human values and skills for solving societal problems and environmental protection

M5: Creating opportunities to the students for experiencing real time problems through project works to enhance employability and entrepreneurship.
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III & VIII Semesters

Scheme and Syllabus

With effect from Academic Year 2019-20

Third Semester B.E. - Scheme

Sl. No.	Course Code	Course Name	Teaching Dept.	Credits	L:T:P:S (Hrs/week)	Marks
1	19MAT31	Integral Transforms & Calculus of Variations	BSC	4	3:0:2:0	100
2	19MET32	Measurements and Manufacturing Process	ME	3	3:0:0:0	100
3	19MET33	Mechanics of Materials	ME	3	3:0:0:0	100
4	19MET34	Computer Aided Machine Drawing	ME	3	2:0:2:0	100
5	19MET35X	Professional Elective - I	ME	3	3:0:0:0	100
6	19MEH36	Universal Human Values	HSMC	3	3:0:0:0	100
7	19MEL37	Measurements and Manufacturing Process Laboratory	ME	2	1:0:2:0	100
8	19MEL38	Material Testing Laboratory	ME	2	1:0:2:0	100
9	19MEH39	Placement Training - I	HSMC	2	2:0:0:0	100
Total				**25**	**21:0:8:0**	**900**

Professional Elective – I

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET351	Conventional Mobility	3	100
2	19MET352	Engineering Metallurgy	3	100
3	19MET353	Numerical Methods and Probability	3	100

Fourth Semester B.E. - Scheme

Sl. No.	Course Code	Course Name	Teaching Dept.	Credits	L:T:P:S (Hrs/week)	Marks
1	19MET41	Thermal Engineering	ME	4	3:0:2:0	100
2	19MET42	Machine Tools and Operations	ME	4	4:0:0:0	100
3	19MEI43	Kinematics of Machines (IC)	ME	4	3:0:2:0	100
4	19MET44X	Professional Elective - II	ME	3	3:0:0:0	100
5	19MET45X	Professional Elective - III	ME	3	3:0:0:0	100
6	19MEL46	Machine Shop Laboratory	ME	2	0:0:4:0	100
7	19MEH47	Constitution of India, Professional Ethics and Human Rights	HSMC	1	1:0:0:0	100
8	19MEH48	Environmental Studies	HSMC	1	1:0:0:0	100
9	19MEH49	Aadalitha Kannada and Vyavaharika Kannada	HSMC	1	1:0:0:0	100
10	19MEH40	Placement Training - II	PT	2	2:0:0:0	1000
	Total Credits			**25**	**21:0:8:0**	**1000**

Professional Elective – II

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET441	Electrical Mobility	3	100
2	19MET442	Advanced Material Science	3	100
3	19MET443	Additive Manufacturing	3	100

Professional Elective – III

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET451	Renewable Energy Resources	3	100
2	19MET452	Management Information System	3	100
3	19MET453	Environmental Air Pollution	3	100

Fifth Semester B.E. - Scheme

Sl. No.	Course Code	Course Name	Teaching Dept.	Credits	L:T:P:S (Hrs/week)	Marks
1	19MET51	Machine Design	ME	3	3:0:0:0	100
2	19MET52	Dynamics of Machines	ME	3	3:0:0:0	100
3	19MEI53	Artificial Intelligence and Robotics (IC)	ME	4	3:0:2:0	100
4	19MET54	Fluid Mechanics	ME	3	3:0:0:0	100
5	19MET55X	Professional Elective IV	ME	3	3:0:0:0	100
6	19MET56X	Professional Elective V	ME	3	3:0:0:0	100
7	19MEL57	Fluid Machinery Laboratory	ME	2	2:0:0:0	100
8	19MEL58	Energy Conversion Laboratory	ME	2	2:0:0:0	100
9	19MET59	Placement Training III	S&H	2	2:0:0:0	100
Total				25	24:0:2:0	900

Professional Elective – IV

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET551	Composites Material Technology	3	100
2	19MET552	Power Plant Engineering	3	100
3	19MET553	Turbo-machines	3	100

Professional Elective – V

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET561	Metal Forming Process	3	100
2	19MET562	Mechatronics	3	100
3	19MET563	Basics of Python for Mechanical Engineers	3	100

Sixth Semester B.E. - Scheme

Sl. No.	Course Code	Course Name	Teaching Dept.	Credits	L:T:P:S (Hrs/week)	Marks
1	19MET61	Finite Element Methods	ME	3	3:0:0:0	100
2	19MET62	Computer Integrated Manufacturing	ME	3	3:0:0:0	100
3	19MET63	Heat and Mass Transfer	ME	4	3:2:0:0	100
4	19MET64X	Professional Elective VI	ME	3	3:0:0:0	100
5	19MET65X	Industrial Elective I	ME	3	3:0:0:0	100
6	19MET666X	Industrial Elective II	ME	3	3:0:0:0	100
7	19MEL67	Computer Integrated Manufacturing Laboratory	ME	2	2:0:0:0	100
8	19MEL68	Heat and Mass Transfer Laboratory	ME	2	2:0:0:0	100
9	19MET69	Placement IV	HSMC	2	2:0:0:0	100
Total				**25**	**24:2:0:0**	**900**

Professional Elective – VI

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET641	Design of Transmission Elements	3	100
2	19MET642	Refrigeration and Air Conditioning	3	100
3	19MET643	Lab View for Industrial Automation	3	100

Industrial Elective – I

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET651	Non-Destructive Testing	3	100
2	19MET652	Operations Research	3	100
3	19MET653	Industrial Internet of Things	3	100

Industrial Elective – II

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET661	Hydraulic and Pneumatic Systems	3	100
2	19MET662	Design of Jigs and Fixture	3	100
3	19MET663	Software Testing	3	100

Seventh Semester B.E. - Scheme

Sl. No.	Course Code	Course Name	Teaching Dept.	Credits	L:T:P:S (Hrs/week)	Marks
1	19MET71	Mechanical Vibrations and Noise	ME	3	2:2:0:0	100
2	19MET72X	Professional Elective VII	ME	3	2:2:0:0	100
3	19MET73X	Professional Elective VIII	ME	3	3:0:0:0	100
4	19MET74X	Industrial Elective III	ME	3	3:0:0:0	100
5	19MEL75	Computer Aided Modelling and Analysis Laboratory	ME	2	2:0:0:0	100
6	19MEL76	Design Laboratory	ME	2	2:0:0:0	100
7	19MEP77	Project Phase I	ME	2	2:0:0:0	100
Total				**18**	**16:4:0:0**	**700**

Professional Elective – VII

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET721	Small and Medium Enterprises	3	100
2	19MET722	Accountancy and Taxation	3	100
3	19MET723	Assessment of Building Energy Performance	3	100

Professional Elective – VIII

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET731	Finite Element Analysis by using Hyper Mesh	3	100

	19MET732	Biomass Energy Systems	3	100
2				
3	19MET733	Automotive Electronics	3	100

Industrial Elective – III

Sl. No.	Course Code	Course Name	Total Credits	Marks
1	19MET741	Machine Learning for Mechanical Engineers	3	100
2	19MET742	Welding Technology	3	100
3	19MET743	Solar Energy	3	100

Eighth Semester B E Scheme

Sl. No.	Course Code	Course Name	Teaching Dept.	Total Credits	Marks
1	19MEP81	Internship	ME	3	100
2	19MEP82	Project Phase II	ME	3	100
3	19MEP83	Project Phase III	ME	4	100
4	19MEP84	Final Viva Voce (External)	ME	8	100
		TOTAL		**16**	**400**

IC –Integrated Course   **L–Lecture**   **T-Tutorials**
P-Practical S – Self Study

Integral Transforms & Calculus of Variations

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MAT31	3:0:2:0	4	CIE:50 SEE:50	3 Hours	BSC

Course Objectives:

This course will enable students to:

- Have the efficiency in expressing a periodic function in terms of infinite trigonometric series.
- Obtain the knowledge of Laplace Transforms.
- Acquire the skill in solving the engineering applications problem using Laplace Transforms.
- Get the ability to solve the engineering problem using Fourier Transforms.
- Develop the proficiency in solving algebraic and transcendental equations and interpolation using numerical methods.

Syllabus

Module – I

Fourier Series: Periodic functions, Dirichlet's conditions, Euler's Formulae (without proof), Fourier series of periodic functions of period 2l and 2π, Half range Fourier series, Practical harmonic analysis, problems.   **09 Hours**

Module – II

Laplace Transform: Definition, Laplace Transform of elementary functions. Properties, transform of derivatives, multiplication by tn and division by t-Problems. Laplace transforms of periodic functions, unit step functions and unit impulse function, problems.   **08 Hours**

Module – III

Inverse Laplace Transforms: Inverse Laplace Transforms of standard functions. (Formulae only). Inverse Laplace transform by using completing the squares, partial fractions, shifting property and differentiation - problems. Convolution theorem - problems. Applications - solution of linear differential equations with initial conditions, problems.   **08 Hours**

Module – IV

Fourier Transforms and Z - Transforms: Complex Fourier transforms Fourier Sine and Cosine transforms and their inverse transforms, problems, Z- Transforms of some standard functions, Damping and shifting rules - problems. Inverse Z – Transforms by partial fraction method.   **08 Hours**

Module – V

Numerical Methods: Numerical solutions of algebraic and transcendental equations- Regula Falsi Method and Newton Raphson Method (Formulae only) – Problems. Finite Differences-Forward and Backward differences, Newton's Forward and Newton's Backward interpolation formulae. Lagrange's Interpolation

formula (without proof)–Problems. Numerical Differentiation using Newton's forward and Backward interpolation formulae, problems. **07Hours**

Course Outcomes:

Upon the completion of the course, the students will be able to:
- Demonstrate Fourier series to study the behavior of periodic functions and their applications in engineering problem.
- Find the Laplace transform of different types of functions.
- Use the Laplace transform and inverse Laplace Transform in solving various types engineering application problems.
- Make use of Fourier transform and Z-transform to illustrate discrete/continuous function arising in engineering applications.
- Determine the roots of Algebraic and Transcendental equations and Interpolation arising in engineering applications, using numerical methods.

Text Books:
1. Dr. B.S. Grewal: "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 42nd Edition, 2012, ISBN:9788174 091955.
2. 2. N.P. Bali and Dr. Manish Goyal: "A Text Book of Engineering Mathematics", Laxmi Publications (P) Ltd., New Delhi, 9thEdition, 2014, ISBN: 9788131808320.
3. DSC, "Engineering Mathematics", 12th edition, Sapana book house, 2015.

Reference Books:
1. Erwin Kreyszig: "Advanced Engineering Mathematics", Wiley Pvt. Ltd. India, New Delhi, 9th Edition, 2011, ISBN 13: 9788126531356.
2. B.V. Ramana: "Higher Engineering Mathematics", Tata Mc Graw – Hill Publishing CompanyLimited, New Delhi, 2nd Reprint, 2007, ISBN 13: 978-0-07063417-0.
3. KSC, "Engineering Mathematics", 8th edition, 2006.

E-Resources:

1. http://bookboon.com/en/essential-engineeringmathematics-ebook

2. https://www.free-ebooks.net/ebook/essential-engineering-mathem

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Measurements and Manufacturing Process Integral

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET32	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Understand the basic objectives of metrology, measurements methods and its advancements.
- Acquire knowledge on different standards of length, calibration of end bars,
- Equip with knowledge of limits, fits, tolerances and gauging.
- Provide knowledge of various casting process and materials used in foundry practice.
- To prepare the moulds by the concept of gating and rise ring systems and to provide adequate knowledge of melting and pouring onto the various casting moulds.

Syllabus

Module – I

Introduction to Metrology: Definition and Objectives of metrology, Measurements: Requirements, methods of measurements, Definitions-Least count, Accuracy, precision and errors in measuring instruments.

Standards of Length: International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-87, M-112), Numerical on building of slip gauges. **08 Hours**

Module – II

System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, geometric tolerance, position-tolerances.

Types of Gauges: plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials. Brief concept of design of gauges (Taylor's principle), Numerical on design of gauges **09 Hours**

Module – III

Introduction to Casting Process: Definition, Classification of manufacturing processes. Introduction to Casting process and steps involved. Varieties of components produced by casting process. Advantages and Limitations of casting process.

Patterns: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns, BIS color coding of Patterns.

Sand Molding: Types of base sand, requirement of base sand, Green sand, dry sand and skin dried moulds, Methods used for sand molding.

Binder: Definition, Types of binder used in molding sand.
Additives: Need, Types of additives used and their properties.   **08 Hours**

Module – IV

Cores: Definition, Need, Types, Method of making cores, Binders used, core sand moulding.

Concept of Gating and Risering: Principle and types.

Preparation of Sand Molds: Molding machines- Jolt type, squeeze type and Sand slinger.

Sand Moulding Process: Green sand, core sand, dry sand, sweep mould, CO_2 mould, shell mould, investment mould.   **07 Hours**

Module – V

Melting Furnace: Cupola construction, zones and operation of conventional Cupola.

Metal Moulds: Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting and Continuous Casting Processes.

Fettling and Cleaning of Castings: Basic steps, casting defects, Causes, features and remedies.

07 Hours

Course Outcomes:

Upon the completion of the course, the students will be able to,

- Understand the objectives of metrology, methods of measurements and calibration of end bars and Describe slip gauges, wringing of slip gauges and building of slip gauges.
- Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design.
- Describe the casting process, Identify various types of patterns, binders, additives, cores and molding machines.
- Explain the mould preparation using Core, Gating, Risering system and Molding Machines.
- Describe the working of cupola furnace used for melting of metals and special types of casting processes.

Text Books:

1. Beckwith, Marangoni, Leinhard: "Mechanical Measurements", Pearson Education, 6th Edition, 2007, ISBN-13: 978-81-317-1718-9.
2. Manufacturing Technology", SeropeKalpakjain, Steuen.R.Sechmid, Pearson Education Asia, 5th Ed. 2006.
3. P.N.Rao: "Manufacturing Technology", Volume-1, Tata McGrawHill, 4th Edition, 2013, ISBN-13: 978-12590-62575.

Reference Books:

1. Materials and Process of Manufacture, Roy A Lindberg, PHI Publications, 2nd edition, 2006.
2. I.C. Gupta, "Engineering Metrology", DhanpatRai Publications, 7th Edition, 2012, ISBN-13: 9788189928452.
3. Principal of Metal Casting, Heine, Loper, Philip Rosenthal, TMH. 1st edition, 2005.

4. Manufacturing Science, by Asok Kumar Mallik & Amitabha Ghosh – Affiliated East-west Press Pvt Ltd, 2nd edition, 2012.

E-resources:
   1. https://nptel.ac.in/courses/112106138/
   2. https://nptel.ac.in/courses/112107144/

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Mechanics of Materials

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET33	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to :

- Understand the characteristics of the ferrous, non ferrous metals and alloys.
- Study the phenomena of fracture, creep and fatigue.
- Perceive the knowledge of fundamental concepts regarding the behavior of deformable bodies under influence of external loading.
- Enlighten with the concept of shear force and bending moment diagrams.
- Developanabilitytoanalyzethethinandthickcylindersandthebehaviorof circular shafts under torsional loads.

Syllabus

Module – I

Ferrous And Non Ferrous Materials: Properties, Composition and uses of Grey cast iron,malleableiron,SGironandsteel,Copperalloys-brassesandbronzes,Aluminium alloys-Al-Cu, Al-Si, Al-Zn alloys, stress-strain diagram for ductile and non-ferrous materials. **08hours**

Module – II

Fracture: Ductile fracture, Brittle fracture and Shear fracture. Griffith's criterion for brittle fracture, Expression for fracture strength of real material based on Griffith's theory, Ductile-brittle transition.

Creep: Three stages of creep, creep properties, Mechanisms of creep.

Fatigue: Types of fatigue loading with examples, Mechanisms of fatigue, fatigue testing and S-N diagram, Introduction to thermal fatigue. **08hours**

Module – III

Simple Stress and Strain: Introduction, stress, strain, types of stress and strain, Elasticity, Plasticity, mechanical properties, Hooke's law, Poisson's ratio, Extension / Shorteningofabar,barswithcrosssectionsvaryinginsteps,principleofsuperposition.

Volumetric strain, expression for volumetric strain of rectangular section bar and cylindrical rod. Elastic constants, simple shear stress, shear strain, temperature stresses in simple bars, relation between elastic constants (without proof) and numerical problems. **08hours**

Module – IV

Shear Force and Bending Moment: Introduction, Types of beams, loads, shear forces and bending moments, sign conventions, Shear force and bending moment diagrams for cantilever, simply supported beams and fixed beams subjected to point load and uniformly distributed load (UDL) and uniformly varying load (UVL) and couple. Relation between shear force and bending moment, numerical problems. **08 Hours**

Module – V

Torsion of Circular Shafts: Introduction, pure torsion ,assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts, numerical problems.

Thick and Thin Cylinders: Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume) Thick cylinders subjected to internal and external pressures, numerical problems. **08Hours**

Course Outcomes:
Upon the completion of the course, the students will be able to,
- Describe the properties and composition of various materials.
- Identify the different types of fracture and fatigue, behavior of material under creep.
- Determine stress, strain and deformation in members subjected to various loads.
- Explain the concepts of shear force and bending moment and can draw shear force and bending moment diagram for beams subjected to different loads.
- Differentiate and determine the stresses in thin and thick cylinders and carryout analysis of torsionalshafts.

Text Books:
1. S.S.Bhavikatti: "Strength of Materials", Vikas publications House Private Limited, 3rd Edition, 2008, ISBN-13: 9788125927914.
2. O.P. Khanna: "Material Science and Metallurgy", Dhanpat Rai Publication, 2nd Edition, 2006, ISBN-13: 9789383182459.
3. S Ramamrutham: "Strength of Materials", Dhanpat Rai Publication, 14th Edition, 2004, ISBN-13: 978-8187433545.

Reference Books:
1. R.C. Hibbeler: "Mechanics of Materials", Pearson Education, 9th Edition, 2013, ISBN: 978-81-317-1502-4.
2. James.M.Gere, Barry J. Goodno: "Mechanics of Materials", Thomson Publication, 6th Edition, 2007, ISBN: 978-81-315-0366-9.
3. George E Dieter: "Mechanical Metallurgy", McGraw Hill Publication, 3rd Edition, 1986, ISBN: 0-07-100406-8.

E- Resources
   1. https://nptel.ac.in/courses/112107146/1
   2. https://www.youtube.com/watch?v=5PVefeA56T8

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Computer Aided Machine Drawing

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET34	2:0:2:0	3	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to :

- Train students to draw the orthographic projections of various machine parts.
- Make the students know about various threads and fasteners.
- Understand different keys and joints used in mechanical assembly and types of riveted joints.
- Know Geometric dimensioning and tolerance of different mechanical components.
- Make the students learn about part modeling, assembly and detailed drawing of the various machine parts.

Syllabus

Module – I

Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.

06 Hours

Module – II

Thread Forms: Thread terminology, Sectional views of threads. ISO Metric (Internal and External) BSW (Internal and External) square and Acme. Sellers thread, American Standard thread.

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut.

07 Hours

Module – III

Keys : Parallel key, Taper key, Feather key, Gibhead key and Woodruff key.

Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets).

07 Hours

Module – IV

Introduction to GD&T: ASME Y14.5-2009 standard, common symbols & their terminologies with examples, feature control frame, datum reference, material conditions, merits of GD&T, applications and case studies.

06 Hours

Module – V
Assembly Drawings (Part drawings should be given)

1. Plummer Block (Pedestal Bearing)

2. Screw Jack (Bottle type)

3. Machine Vice

4. Universal Joint

5. Knuckle Joint   **13Hours**

Course Outcomes:

On completion of this course, the students are able to :
- Draw the orthographic projections of various machine parts.
- Create use, identify and explain various threads and fasteners.
- Identify and explain different keys and joints used in mechanical assembly and types of riveted joints.
- Write different GD&T terminologies for a drawing, based on ASME Y14.5-2009 standard.
- Use standard software tools to create engineering drawings or other documents to fully describe the geometries and dimensions of parts, as well as to document on part modeling, assembly and detailed drawing of the various machine parts.

Text Books:
1. N.D.Bhatt: "Machine Drawing", 45th Edition, Charotar Publishers, 2008, ISBN: 81-85594-38-4.
2. K.R.Gopalkrishna: "Machine Drawing", 22nd Edition, Subhas Publication, 2013.
3. K L Narayana& K Venkata Reddy "Machine Drawing" (Chapters 1-3), New age International, 4th edition.

Reference Book:
1. S. Trymbaka Murthy: "A Text Book of Computer Aided Machine Drawing", CBS Publishers and Distributors Pvt. Ltd., 2008, ISBN-13: 9788123916590.
2. **A Primer on Computer Aided Machine Drawing-2007'**, Published by VTU, Belgaum.
3. **Machine Drawing,** N. Siddeshwar, P.Kannaiah, V.V.S.Sastry, Tata Mc GrawHill, 2nd edition 2006, ISBN-13: 978-0074603376.

Pre-requisites:

The student should have knowledge of Computer Aided Engineering Drawing.

Scheme of Evaluation:

Continuous Internal Evaluation (CIE)

CIE - 1 - 30 marks

CIE – 2 - 30 marks

Surprise test - 10 marks

Submission of sketch Book - 30 marks

Total - 100 marks

Semester End Examination (SEE)

Part A – Module 1 or Module 2 - 20 marks

Part B – Module 3 or Module 4 - 20 marks

Part C - Module 5 - 60 marks

Total - 100 marks

Note: One question to be set from Module 1,2,3 and 4 each. Two Questions are to be

set from Module 5. Students have to answer any one question from each part.

E-Resources

1. https://www.youtube.com/results?search_query=Orthographic+Views+nptel+videos
2. https://www.youtube.com/results?search_query=Assembly+Drawings++nptel+videos

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Conventional Mobility

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET351	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to:

- Understand IC engine, its components and different types of fuels
- Develop skills in fuel supply systems for SI and CI engines
- Understand the principle of superchargers & turbochargers
- Know the importance of ignition system
- Analyze the flame propagation in combustion in SI and CI engine

Syllabus

Module – I

I C Engine Components: SI & CI engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Compression ratio, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, different lubrication arrangements

08 Hours

Module – II

Fuels, Fuel Supply Systems for SI and CI Engines: Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers, Fuel mixture requirements for SI engines, Simple carburetor & C.C. carburetor, multi point and single point fuel injection systems, fuel transfer pumps, fuel filters, fuel injection pumps and injectors.   **08 Hours**

Module – III

Superchargers and Turbochargers: Naturally aspirated engines, forced induction, Types of superchargers, Centrifugal type, Roots blower, Vane blower.

Turbocharger construction and operation, Limitations of turbo charging, Intercooler, Turbocharger lag.   **08 Hours**

Module – IV

Ignition Systems: Battery Ignition systems, magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems.

Automotive Chassis: Types of chassis layout with reference to power plant locations and drive, Vehicle frames. Various types of frames. Constructional details, Materials. Testing of vehicle frames. Unitized frame body construction: Loads acting on vehicle frame.   **08Hours**

Module – V

Combustion in S.I. Engines and Combustion in C.I. Engines: Initiation of combustion, flame velocities, effect of variables on flame propagation, normal and abnormal combustion, pre-ignition, surface ignition, detonation, theories of detonation, effects of engine variables on detonation, effects of detonation, control of detonation, Various

stages of combustion, vaporization of fuel droplets and spray formation, air motion, swirl, squish, tumble flow, velocities, diesel knock and its effect, methods of controlling diesel knock.

Safety:- Air bag system, Adoptive Cruise Control (ACC), automatic emergency braking, lane departure warning, blind spot detection, safety exit assistant. **08 Hours**

Course Outcomes:
Upon the completion of the course, the students will be able to,

- Describe IC engine, its components
- Analyze the selection of fuels
- Demonstrate the concept of supercharger & turbocharger
- Get exposed to knowledge of ignition system
- Understanding the concept of Combustion in SI and CI Engine.

Text Books:
1. William H Crouse & Donald L Anglin, "Automotive mechanics", Tata McGraw Hill Publishing Company Ltd, 10th Edition, 2006, ISBN-13:9780070634350.
2. Kirpal Singh, "Automobile engineering", Vol 1 and 2, Standard Publishers, 12th Edition, 2011, ISBN-13: 9788180141713.
3. Giancarlo Genta Lorenzo Morello, "The Automotive Chassis- Components Design", Vol I, Springer, 2018, ISBN-978-1-4020-8676-2

Reference Books:
1. R. B. Gupta, "Automobile Engineering", Satya Prakashan publisher, 4th Edition, 2015, ISBN-13:9788176843799
2. S. Srinivasan, "Automotive Mechanics", McGraw Hill Education (India) Private Limited, 2ndEdition , 2003, ISBN-13: 978-0070494916.
3. K K Jain, "Automobile Engineering ", Tata McGraw Hill Education (India) Private Limited, 2010, ISBN 0-07-044529-6.

E Resources:
1. https://nptel.ac.in/courses/112103262/
2. https://nptel.ac.in/courses/112104033/27
3. https://nptel.ac.in/courses/101101001/27

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Engineering Metallurgy

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET352	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to :

- Understand the fundamentals of structure-property correlation by familiarizing them with crystalline materials, their properties and their defects.
- Gain the knowledge on basics of solidification, solid solutions and phase diagrams**.**
- Learn the importance of Fe-C equilibrium diagram and the TTT diagrams and the difference between them.
- Study the various heat treatment processes and its importance.
- Know the fundamentals of ceramics and polymers used in engineering applications.

Syllabus

Module – I

Crystal Structure: BCC, FCC and HCP Structures, coordination number and atomic packing factor, crystal imperfections, Atomic Diffusion: Mechanisms, Fick's laws of diffusion, factors affecting diffusion, simple problems.   **08 Hours**

Module – II

Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures. Phase Diagram I: Solid solutions Hume Rothary rule, substitution and interstitial solid solutions, intermediate phases, Gibbs phase rule.   **07 Hours**

Module – III

Phase Diagram II: Construction of equilibrium diagrams involving complete and partial solubility, lever rule, Iron carbon equilibrium diagram, description of phases, solidification of steels and cast irons, invariant reactions. TTT curves, continuous cooling curves.   **08 Hours**

Module – IV

Heat treating of metals: Introduction, classification of heat treatment processes, annealing and its types. normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys   **08 Hours**

Module – V

Ceramics: Nature and structure of ceramics, Refractory, clay products, Abrasive glasses, glass ceramics, cements, advanced ceramics, Engineering Applications, processing methods for ceramic materials.

Polymers and Polymerizations: Structure and properties of thermoplastics and thermosets characteristics and engineering applications.   **08 Hours**

Course Outcomes:
Upon the completion of the course, the students will be able to,
- Explain the structure of material and atomic diffusion.
- Describe the mechanism of solidification and types of phase diagrams.
- Identify different types of phases, invariant reactions in iron-carbon phase diagram.
- Analyze various heat treatment processes.
- Explain the structure and properties of ceramics and polymers.

Text Books:
1. William D. Callister: "Materials Science and Engineering-an introduction", John Wiley and Sons, 4th Edition, 2012, ISBN: 1118061608
2. James F.Shackelford, M K Muralidahar: "Introduction to Materials Science for Engineers ", Pearson Publication, 6th Edition, 2007, ISBN: 978-81-317-0090-7
3. Donald R. Askeland, Pradeep P.Phule: "Essentials of Materials For Science And Engineering", Thomson-Engineering,2nd Edition 2014, ISBN 10: 0534253091.

Reference Books:
1. Alan Cottrell, "An Introduction to Metallurgy", Universities Press, 2nd Edition, 1990, ISBN: 8173712395.
2. T.V.Rajan and C.P. Sharma, Ashok Sharma, "Heat Treatment: Principles and Techniques", Prentice Hall of India, New Delhi, 2nd Edition 2007, ISBN 13: 9788120307162.
3. V Raghavan: "Physical Metallurgy", PHI, New Delhi ,2nd Edition, 2006, ISBN 13:

E Recourse:
1. https://nptel.ac.in/courses/113104014/16
2. https://nptel.ac.in/courses/113104068/
3. https://nptel.ac.in/courses/113105024/31

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Numerical Methods and Probability

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET353	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:
This course will enable students to:
- Acquire the knowledge of calculus of complex functions.
- Develop the proficiency in solving Numerical integral and Initial value problems.
- Obtain the knowledge of probability distributions.
- Learn concept of the Joint distributions and Markov's chains.
- Known the importance of statistical inference in engineering.

Syllabus

Module – I

Complex Variables: Complex variables: Functions of a complex variable, derivative of complex functions. Analytic functions, (No problems by using limits). Cauchy's-Riemann equations in Cartesian and polar forms, Harmonic functions –problems (No problems by using limits). Construction of analytic functions by using Milne-Thomson method - problems.

Complex integration: Line integrals -problems. Cauchy Theorem (no problems on verification of the theorem) and Cauchy's integral formula, problems.   **08 Hours**

Module – II

Numerical Methods: Numerical Integration-Trapezoidal rule, Simpson's 1/3rd and 3/8th rule. Numerical solutions of ordinary differential equations of first order and first degree- Picard's method, Taylor's Series method, Modified Euler's Method, Runge-Kutta Method of 4th order and Milne's Predictor Corrector Method(without proof), problems.   **08 Hours**

Module – III

Random Variables and Probability Distribution: Discrete and continuous Random Variables, Probability density function and distributions. Binomial, Poisson, Exponential and Normal distributions.   **08 Hours**

Module – IV

Joint Probability and Markov's Chain: Joint Probability distribution of two discrete random variables. Expectations, correlation and covariation. Probability vectors, stochastic matrices, fixed point matrices, regular stochastic matrices, Markov's Chains, higher transition probabilities, stationery distribution of regular Markov's Chains.

08 Hours

Module – V

Sampling and inference: Sampling Distribution, Testing of hypothesis, level of significance, confidence limits, test of significance of large samples, sampling of variables, central limit theorem, confidence limits for unknown means, Students t-

distribution and Chi-square test. **07 Hours**

Course Outcomes:
On completion of this course, the students are able to:
- Use the concepts of analytic functions and complex integration in engineering application problems.
- Solve the Numerical integral and Initial value problems arising in engineering applications, using numerical methods.
- Apply probability distributions in analyzing the probability models arising in engineering field.
- Apply Joint probability distributions and Markov's chains in analyzing the probability models arising in engineering field.
- Use the concept of sampling analysis in analyzing the statistical models arising in engineering field.

Text Books:
1. Dr. B.S. Grewal: "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 42nd Edition, 2012, ISBN: 9788174091955.
2. N.P. Bali and Dr. Manish Goyal: "A Text Book of Engineering Mathematics", Laxmi Publications (P) Ltd., New Delhi, 9th Edition, 2014, ISBN: 9788131808320.
3. Seymour Lipschutz and Marc Lars Lipson: "Probability", McGraw Hill Education (India) Private Limited, Chennai, Special Indian Edition, 2010, ISBN: 978-0-07-014622-8.

Reference Books:
1. Erwin Kreyszig: "Advanced Engineering Mathematics", Wiley Pvt. Ltd., India, New Delhi, 9th Edition, 2011, ISBN 13: 9788126531356.
2. B.V. Ramana: "Higher Engineering Mathematics", Tata McGraw – Hill Publishing Company Limited, New Delhi, 2nd Reprint, 2007, ISBN 13: 978-0-07063417-0.
3. J.P. Singh, "Probability & Numerical Methods", 11th edition, 2008.

E-Resources:
1. http://bookboon.com/en/essential-engineering-mathematics-ebook
2. https://www.free-ebooks.net/ebook/essential-engineering-mathematics
3. https://archive.org/details/AdvancedEngineeringMathematics10thEdition
4. http://www.zums.ac.ir/ebooks/mathematics/essential-engineering

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Universal Human Values

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEH36	3:0:0:0	3	CIE:50 SEE:50	3 Hours	HSMC

Course Objectives:
- To help students distinguish between values and skills, and understand the need, basic guidelines, content and process of value education.
- To help students initiate a process of dialog within themselves to know what they 'really want to be' in their life and profession
- To help students understand the meaning of happiness and prosperity for a human being.
- To facilitate the students to understand harmony at all the levels of human living, and live accordingly.
- To facilitate the students in applying the understanding of harmony in existence in their profession and lead an ethical life

Syllabus

Module – I

Introduction to Value Education:- Value Education, Definition, Concept and Need for Value Education, The Content and Process of Value Education, Basic Guidelines for Value Education, Self exploration as a means of Value Education, Happiness and Prosperity as parts of Value Education.   **08 Hours**

Module – II

Harmony in the Human Being: Human Being is more than just the Body, Harmony of the Self ('I') with the Body, Understanding Myself as Co-existence of the Self and the Body, Understanding Needs of the Self and the needs of the Body, Understanding the activities in the Self and the activities in the Body.   **09 Hours**

Module – III

Harmony in the Family and Society and Harmony in the Nature:- Family as a basic unit of Human Interaction and Values in Relationships, The Basics for Respect and today's Crisis: Affection, e, Guidance, Reverence, Glory, Gratitude and Love, Comprehensive Human Goal: The Five Dimensions of Human Endeavour, Harmony in Nature: The Four Orders in Nature, The Holistic Perception of Harmony in Existence.

09 Hours

Module – IV

Social Ethics: The Basics for Ethical Human Conduct, Defects in Ethical Human Conduct, Holistic Alternative and Universal Order, Universal Human Order and Ethical Conduct, Human Rights violation and Social Disparities.   **08 hours**

Module – V

Professional Ethics: Value based Life and Profession, Professional Ethics and Right Understanding, Competence in Professional Ethics, Issues in Professional Ethics – The Current Scenario, Vision for Holistic Technologies, Production System and Management Models. **08 Hours**

Course Outcomes:

On completion of this course, the students will be able to

- Understand the significance of value inputs in a classroom and start applying them in their life and profession
- Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc
- Understand the value of harmonious relationship based on trust and respect in their life and profession
- Understand the role of a human being in ensuring harmony in society and nature.
- Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.

Text Books:

1. A.N Tripathy, New Age International Publishers, 2003.
2. Bajpai. B. L , , New Royal Book Co, Lucknow, Reprinted, 2004
3. Bertrand Russell Human Society in Ethics & Politics, 2004.

Reference Books:

1. Corliss Lamont, Philosophy of Humanism
2. Gaur. R.R. ,Sangal. R, Bagaria. G.P, A Foundation Course in Value Education, Excel Books, 2009.
3. Gaur. R.R. ,Sangal. R ,Bagaria. G.P, Teachers Manual Excel Books, 2009.
4. I.C. Sharma . Ethical Philosophy of India Nagin & co Julundha
5. Mortimer. J. Adler, – Whatman has made of man
6. William Lilly Introduction to Ethic Allied Publisher

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Measurements and Manufacturing Process Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEL37	1:0:2:0	2	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to :

- Know importance of calibration of measuring instruments.
- Learn linear, angular measurement and threaded gear parameters.
- Understand the testing of Moulding sand.
- Prepare the mould using cope and drag boxes with patterns and learn the design of gating system.
- Operate the 3D printing equipment by using various types of materials.

Syllabus

PART-A

Mechanical Measurement and Metrology

1. Calibration of LVDT/ thermocouple.
2. Calibration of pressure gauge/pressure transducer.
3. Measurements of angle using sine center and sine bar
4. Measurements of angles using bevel protractor
5. Determination of screw profile by using optical profile projector.
6. Determination of gear tooth profile using gear tooth vernier.

PART-B

Testing of Moulding sand
1. Compression on Universal Sand Testing Machine
2. Permeability Test
3. Grain Fineness Number Test (Sieve Analysis Test)
4. Clay Content test

Foundry Practice:

1. Preparation of Moulds using Two Moulding Boxes with patterns and design of gating system.

PART-C
1. Demonstration of 3D Printing

Course Outcomes:

Upon the completion of the course, the students will be able to,

- Work with various measuring equipment applied to engineering analysis in industries.
- Recognize the screw thread and gear tooth parameters.
- Conduct tests on foundry sands to determine properties for different ingredient compositions.
- Apply knowledge of design and practices of mould and pattern making and design of gating system.
- Apply knowledge of 3D printing

Scheme of Examination:

One question is to be set from Part-A: 20 Marks

One question is to be set from Part-B : 20 Marks

Viva-Voce : 10 Marks

Total: 50 Marks.

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Material Testing Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEL38	1:0:2:0	2	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Study the microstructure of ferrous and non-ferrous materials.
- Conduct the Non-Destructive Tests on various materials.
- Understand the effect of heat treatment on the material properties.
- Learn the method of conducting wear test.
- Understand the mechanical behavior of material under the application of different types of loads.

Syllabus

PART A

1. Preparation of Specimen for Metallographic Examination of Different Engineering Materials. (Identification of Microstructures of plane carbon steel, tool steel, gray C.I, SG iron, brass and bronze).
2. Heat treatment: Annealing, Normalizing and Hardening of steel.
3. To locate surface-breaking defects in all non-porous materials using dye penetration test.
4. To detect surface / slightly subsurface discontinuities in ferromagnetic materials using magnetic crack detection.

PART B

1. To study the wear characteristics of ferrous and non-ferrous materials.
2. Tensile, Shear and Compression tests of metallic specimen using a Universal Testing Machine.
3. To carryout bending test on Metallic and Non-Metallic Specimens.
4. To find the impact strength of ferrous material using Izod and Charpy Tests.
5. To find the hardness of ferrous and non-ferrous materials using Brinell and Rock-well tester.

Course Outcomes:

On completion of this course, the students are able to :

- Prepare the sample for microstructure identification and identify the metals based on their Microstructure.
- Capable of detecting the defects by using the NDT methods.
- Improve the structure/behavior of materials for various industrial applications using heat- treatment processes.
- Carryout out wear test and determine the wear characteristics of the metals.

- Demonstrate the knowledge and the skills required for the conduction and analyzing the results of Tensile, Shear, Compression and Bending Test.

Conducting classes: Classes may be conducted in one slot per week, of 3 Hours
(Instruction 1 hr. + Conduction and Calculation 2 hr.)

Scheme of Examination:

Individual Experiment	15 Marks
Group Experiment	25 Marks
Viva –Voce	10 Marks
Total Marks	50 Marks

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Thermal Engineering

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET41	3:0:2:0	4	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to :

- Learn the fundamentals of thermodynamics and related definitions to understand the temperature concept and thermodynamic principles.
- Impart the concept of work and heat and the laws of thermodynamics.
- Developtheabilitytoanalyzetheengineeringdevicesandtocalculatework done, heat transfer and other properties.
- Understand the principle of entropy and behavior of pure substances.
- Know the principles of ideal gases and real gases.

Syllabus

Module – I

Laws of Thermodynamics: Joules experiments, equivalence of heat and work, Zeroth law of thermodynamics, Statement of the First law of thermodynamics, extension of the First law to non- cyclic processes, energy, energy as a property, modes of energy. Extension of the First law to control volume, steady state-steady flow energy equation, important applications, analysis of unsteady processes such as film and evacuation of vessels with and without heat transfer, Kelvin-Plancks statement of the Second law of Thermodynamics: PMM I and PMM II, Clausius statement of Second law of Thermodynamics ,Equivalence of the two statements.

08Hours

Module – II

Entropy Clausius in equality: Statement, proof, application to a reversible cycle. Entropy: definition, a property, change of entropy, principle of increase in entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Energy),Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility, second law efficiency, numerical problems. **08 Hours**

Module – III

Air Standard Cycles: Carnot, Otto, Diesel and Dual cycles, P-V and T-S diagrams, description and efficiencies, concept of mean effective pressure, comparison of Otto, Diesel and Dual combustion cycles, numerical problems. **08 Hours**

<div align="center">**Module – IV**</div>

Internal Combustion Engines: Testing of two stroke and four stroke SI and CI engines for performance, Related numerical problems, heat balance, Motoring Method, Willian's line method, Swinging field dynamometer, Morse test, numerical Problems.   **08Hours**

<div align="center">**Module – V**</div>

Psychometric and Air Conditioning: Definition, psychometric properties; dry bulb temperature,wet bulb temperature, dew point temperature, partial pressures, specific,   absoluteandrelativehumidity's,degreeofsaturation,adiabaticsaturation temperature,enthalpyofmoistair,psychometricrelations,psychometricprocesses, summer and winter air-conditioning, numerical Problems   **08Hours**

Course Outcomes:

Upon the completion of the course, the students will be able to,

- Demonstrate the use of zeroth law of thermodynamics in temperature measurements and also the work and heat transfer in a Thermodynamic system.
- Formulate the heat, work and energy of the system for various thermodynamic processes.
- Evaluate the performance of heat engines and heat pumps/refrigerators.
- Analyze the Entropy change for various thermodynamic processes.
- DescribetheThermodynamicpropertiesofpuresubstancesandtodistinguish between ideal and real gases.

List of Experiments:

1. Determination of Caloric value of gaseous fuels.
2. Exhaust gas analysis system
3. Measurement of an area of Indicator diagram using plan meter.
4. Performance testing of 2-stroke air cooled, mechanically loaded petrol engine.
5. Studies on humidification of air.
6. Morse test on a multi-cylinder engine.
7. Performance testing of 4-stroke diesel engine with heat balance analysis.

Text Books:

1. P. K.Nag, "Basic and Applied Thermodynamics", Tata McGrawHill Publications,2nd Edition,2002, ISBN-13: 978-0070151314.
2. YunusA.Cenegal and Michael A.Boles, "Thermodynamics, An Engineering Approach", Tata McGraw Hill Publication, 2002, ISBN 13: 9780070495036
3. B.K.Bhaskar, "Thermal Engineering", McGraw Hill, 4th edition, 2009.

Data Hand Books:-

1. B.T.Nijaguna,B.S.Samaga,"ThermodynamicDataHandBook",SudhaPublications, ISBN-13:1234567147821
2. R.Niranjanmurthy,"ThermodynamicDataHandBook",PublishedbySapnabook house, ISBN-13:9788128000041

Reference Books:

1. A.Venkatesh, "Basic Engineering Thermodynamics", Universities Press, 2008, ISBN-13: 978-8173715877.
2. J.B.JonesandG.A.Hawkins,"Engineering Thermodynamics", John Wiley and Sons, ISBN 13: 9780471812029
3. B.K Venkanna, Swati B. Vadavadagi, "Basic Thermodynamics", PHI, New Delhi, 2010, ISBN-13: 978-8120341128

E-resources:

1. https://nptel.ac.in/courses/112108148/
2. https://nptel.ac.in/courses/112104113/6
3. https://nptel.ac.in/courses/101104067/12

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Machine Tools and Operations

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET42	4:0:0:0	4	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Understand the fundamentals of cutting tools and metal cutting processes and to develop the knowledge on mechanics of machining process.
- Introduce to different machine tools such as Lathes & drilling machines in order to produce components having different shapes and sizes.
- Gain the knowledge of milling operations and indexing mechanism.
- Know the elements of grinding wheel and its operations &Understanding the recent advancement in the areas of machining in terms of numerically controlled machine tool.
- Understand the various aspects of different machine tools, jigs and fixture, locating clamp positions.

Syllabus

Module – I

Theory of Metal Cutting: Introduction, Basic elements of machining, Single point cutting tool nomenclature, orthogonal and oblique cutting, mechanism of chip formation, types of chips, tool wear, Mechanism of wear, tool failure, effect of cutting parameters, tool life criteria, Taylor's tool life equation, numerical problems on tool life equation.

Machinability: Factors affecting Machinability, heat generation in metal cutting, factors affecting heat generation, measurement of tool tip temperature.

Cutting Tool Materials: Desired properties, types of cutting tool materials- HSS, carbides, coated carbides, and ceramics.

Cutting Fluids: Introduction, functions of metal working fluids, types of cutting fluids, desired properties and selection of Cutting fluids. **09 Hours**

Module – II

Lathes and its Mechanism: Introduction, Classification of lathes, Capstan and turret lathes- constructional features, difference between Turret & Capstan Lathe, Driving mechanisms of Turret lathe, Different operations on lathe, tool layout of producing hexagonal bolt on a capstan lathe.

Drilling: Drill bit nomenclature, Types of drills, Types of Drilling machines, operations- Boring, Reaming, Tapping, trepanning, counter boring and countersinking, Numerical on machining time. **08 Hours**

<div align="center">**Module – III**</div>

Milling Machines: Introduction, Principle of milling, concepts of up milling and down milling, Classification of milling machines-Column and knee type milling, bed type milling machine, Nomenclature of a milling cutter, milling operations.

Indexing: Indexing methods, calculations and problems on simple and compound indexing. **07 Hours**

<div align="center">**Module – IV**</div>

Grinding machines: Introduction, working principle, Types of abrasives, bonding process, Classification-Surface grinding & Cylindrical grinding machines, Constructional features, standard designation, selection of grinding wheel, dressing and truing of grinding wheel.

Shaping and planning machine: Classification, driving mechanisms, shaping and planning operations.

Numerical Control of machine tools:

General architecture of CNC Machine, Components of the CNC Systems: Machine Control Unit, CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors **08 Hours**

<div align="center">**Module – V**</div>

Jigs & Fixtures: Elements of Jigs and fixtures, principles of location, types of locating and clamping elements, Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation, Drill bushes-their types and applications indexing devices, auxiliary elements, Types of jigs, Milling fixture and turning fixture (Case study)

<div align="right">**07 Hours**</div>

Course Outcomes:

Upon the completion of the course, the students will be able to,

- Uses of the various cutting forces acting in metal cutting on cutting tool materials and their tool life
- Students will understand the working of Capstan and Turret lathes, drilling machine, reaming machines.
- Apply the design aspects of jigs and fixture by locating the clamps on position.
- Comprehend the Characteristics of grinding wheel and the recent advancement in the areas of machining in terms of numerically controlled machine tool.
- Demonstrate the knowledge in machining and newer techniques adopted in industries to solve the real-world problems in production.

Text Books:

1. Hajra Choudhry: "Workshop Technology Vol-II", Media Promoters and Publishers Pvt. Ltd., 2nd Edition, 2010, ISBN: 81-85099-15-4.
2. R.K.Jain: "Production Technology", Khanna Publications, 17th Edition, 2014, ISBN: 81-7409-099-1.
3. RK Rajput: "Manufacturing Technology", Second edition-2015, Laxmi Publications, ISBN: 978-81-318-0244-1.
4. Joshi, P.H. "Jigs and Fixtures", Second Edition, Tata McGraw Hill Publishing Co.,Ltd., New Delhi, 2004, ISBN: 978-1259061226.

Reference Books:

1. Amitabha Ghosh and Ashok Kumar Mallik: "Manufacturing Science", East West Press, 2nd Edition, 2010, ISBN-13: 978-81-7671-063-3.
2. G. Boothroyd: Winston A. Knight, "Fundamentals of Metal Machining and Machine Tools", CRC Press, 3rd Edition, 2005, ISBN 13: 978-1574446593.
3. K. Venkataraman, "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, NewDelhi, 2005, ISBN: 978-11-1915-567-6.

E-resources:

1. https://nptel.ac.in/downloads/112105127/
2. https://nptel.ac.in/courses/112105126/
3. https://nptel.ac.in/courses/112105127/pdf/LM-02.pdf
4. https://nptel.ac.in/courses/112105126/34

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Kinematics of Machines(IC)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEI43	3:0:2:0	4	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Understand the fundamentals of Kinematics of machines and how to determine the mobility of mechanisms.
- Know the various mechanisms, its inversions and applications.
- Learn the velocity and acceleration analysis of mechanisms using graphical method.
- Study the concepts of gear mechanism, gear train and terminologies involved in spur gears.
- Understand the method of drawing cam profiles depending on type of motion.

Syllabus

Module – I

Introduction: Definitions of link or element, kinematic pairs, degrees of freedom, Grubler's criterion (without derivation), kinematic chain, mechanism, structure, mobility of mechanism, inversion, machine, kinematic chains and inversions. Inversions of four bar chain, single slider crank chain and double slider crank chain.

08Hours

Module – II

Mechanisms: Quick return motion mechanisms , straight line motion mechanisms-Peaucellier'smechanismandRobert'smechanism,intermittentmotionmechanisms–Geneva mechanism and ratchet and pawl mechanism, pantograph, Ackerman steering gear mechanism.   **08Hours**

Module – III

Velocity and Acceleration Analysis of Mechanisms (Graphical Methods): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism.

Velocity and Acceleration Analysis of Mechanisms (Instantaneous center Method): Definition of Instantaneous centre, types of instantaneous centers, Kennedy's theorem and Numericals on velocity and acceleration analysis of four bar chain and single slider crank chain using instantaneous center method.   **08 Hour**

Module – IV

Spur Gears: Gear terminology, law of gearing, characteristics of involutes action, pathofcontact,arcofcontact,contactratio,interferenceininvolutesgears,methods   of

avoiding interference, comparison of involutes and cycloidal teeth, numerical problems. Introduction to gear trains and types of Gear trains.   **08Hours**

Module – V
Cams: Types of cams, types of followers, displacement, velocity and acceleration time curves for cam profiles, disc cam with reciprocating follower having knife-edge, roller and flat faced follower. Follower motions including, SHM, Uniform velocity, uniform acceleration and retardation and cycloidal motion, numerical problems. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to:
- Calculate mobility and enumerate rigid links and types of joints within mechanisms.
- Identify and select the proper mechanisms for application in real life situations.
- Construct the velocity and acceleration diagrams and determine the link velocities and accelerations.
- Identifydifferentgears,geartrainsandsolvesimpleproblemsonspurgears.
- Draw the cam profile for specific follower motion

Lab Experiments:

1. To study various types of Kinematic links, pairs and mechanisms
2. Position analysis of Grashoff four bar mechanism.
3. Velocity analysis of Grashoff four bar mechanism.
4. Acceleration analysis of Grashoff four bar mechanism.
5. To study various types of gears.
6. To study various types of gear trains.

Text Books:
1. Sadhu Singh: "Theory of Machines", Pearson Education, 2nd Edition, 2007, ISBN-13: 9788177581270.
2. Thomas Bevan: "Theory of Machines", CBS Publications, 3rd Edition, 2005, ISBN-13: 978-8123908748.
3. J. B. K Das, P.L. Srinivasa Murthy: "Kinematics of Machines", Sapna Book House (P) Ltd12th Edition,2016, ISBN: 978-81-280-0221-2

Reference Books:
1. Rattan S.S: "Theory of Machines", Tata McGraw Hill Publishing Company Ltd. New Delhi, 4th Edition, 2014, ISBN-13: 9789351343479
2. Robert L. Norton, "Design of Machinery", McGraw Hill, 5th Edition, 2011,

ISBN-13: 978- 0077421717.

3. R.S. Khurmi, J.K. Gupta: "Theory of Machines", S. Chand and Company Ltd. New Delhi, 14th Edition, 2008, ISBN: 81-219-2524-X

E- Resources

1. https://nptel.ac.in/courses/112104121/1

2. http://mm-nitk.vlabs.ac.in/

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Electrical Mobility

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET441	3:0:0:0	3	CIE:50 SEE:50	3 hours	PEC

Course Objectives:

This course will enable students to :

- Understand working principle of hybrid and electric vehicles
- Develop skills in drive to wheels
- Study the concept of suspension, springs and brakes
- Impart the knowledge of automotive emission control system
- Gain knowledge of basic parameters of engine test

Syllabus

Module – I

Hybrid and Electric Vehicles: Hybrid vehicles – Basic concept of hybrid traction, components, power flow control in hybrid traction. Introduction to electric vehicles, components, electric drive trains, power flow control in electric drive train, Battery system type and efficiency, charging system, fast charging, slow charging differences.

07 hours

Module – II

Power Trains: Principle of friction clutches and constructional details, Fluid flywheel, Single plate, multi-plate and centrifugal clutches, Numerical.

Gear box: Necessity for gear ratios in transmission, synchromesh gear box. Freewheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epi-cyclic gear box, principles of automatic transmission, calculation of gear ratio. **08 hours**

Module – III

Drive to wheels: Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering- hydraulic and electric power assisted, over steer, under steer and neutral steer and Multi axle drive.

08 hours

Module – IV

Suspension and springs: Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system.

Brakes: Types of brakes, mechanical, air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system. **08 hours**

Module – V

Automotive emission control systems: Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Catalytic converter, Emission standards- BS1-, BS4 and BS6.   **08 hours**

Course Outcomes:

Upon the completion of the course, the student should be able to,
- Describe the working principle of hybrid and electric vehicles
- Analyze the working of power trains & gear box, drive of wheels.
- Demonstrate the concepts of suspension, springs & brakes
- Apply knowledge of emission control system
- Evaluate the performance parameter and engine test.

Text Books:
1. William H Crouse & Donald L Anglin, "Automotive mechanics", Tata McGraw Hill Publishing Company Ltd, 10thEdition, 2006, ISBN-13:9780070634350.S.
2. Srinivasan, "Automotive Mechanics", McGraw Hill Education (India) Private Limited, 2ndEdition , 2003, ISBN-13: 978-0070494916
3. Giancarlo Genta Lorenzo Morello, "The Automotive Chassis- Components Design", Vol I, Springer, 2018, ISBN-978-1-4020-8676-2

Reference Books:
1. R. B. Gupta, "Automobile Engineering", Satya Prakashan   publisher, 4th Edition, 2015,   ISBN-13:9788176843799
2. Kirpal Singh, Vol I and II, "Automobile engineering", Standard Publishers, 12th Edition, 2011, ISBN-13: 9788180141713
3. K K Jain, "Automobile Engineering ", Tata McGraw Hill Education (India) Private Limited, 2010, ISBN 0-07-044529-6.

E-Recourses:
1. https://nptel.ac.in/courses/108103009/30
2. https://nptel.ac.in/courses/Webcourse-contents/IIT-ROORKEE/.../lecture20.html
3. https://nptel.ac.in/courses/108103009/

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Advanced Material Science

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET442	3:0:0:0	3	CIE:50 SEE:50	3 hours	PEC

Course Objectives:

This course will enable students to :

- Understand the various aspects related to composite materials and micromechanics of laminar.
- Gain the knowledge of powder metallurgy and its techniques.
- Study about materials for high temperature resistance and their applications.
- Perceive the knowledge of selection of different coating material and methods of surface technology.
- Know about the nano particles, preparation methods, applications, characterization and also knowledge about carbon nanotubes and its types.

Syllabus

Module – I

Composite Materials: Classification of composites, types and role of matrices and reinforcements, characteristics and selection, particulate composites, laminates; sandwich structures. Production of FRP's or PMC's (Hand lay-up, Filament Winding, Spray lay-up, Pultrusion, Injection Moulding), MMC's (Stir casting, Squeeze casting, diffusion bonding), need for MMCs.

Micromechanics of laminate: Rule of mixture for evaluation of physical and elastic properties of laminate (density, thermal conductivity, elastic moduli, ultimate tensile strength), numerical problems.   **08 Hours**

Module – II

Powder Metallurgy: Basics and application, Steps in Powder Metallurgy, Methods of powder production, Compaction techniques like CIP and HIP (Cold isostatic and Hot isostatic pressing), Sintering mechanism, Secondary Operations, Process details and special characteristics of powder metallurgy process, Advantages and Limitations.
                                                                                    08 Hours

Module – III

High temperature alloys: Classification of Titanium alloys, properties, microstructure and applications, heat treatment and machining of Ti alloys, Nickel chromium alloy, C263 alloy, oxide formation-sulfidation.   **08 Hours**

Module – IV

Surface Technology: Coatings for specific applications, coating materials and their selection, Coating formation and bonding mechanism, coating technologies and their merits and demerits, coating characterization, Use of LASER for coating life enhancement, hard facing, metallic and non-metallic surface modifications with thin films**.**   **08 Hours**

Nanotechnology: Nano powders and nano materials, Properties of nanomaterials, Fabrication Techniques- Top-Down approach and Bottom-Up approach, methods of preparation- plasma arcing, chemical vapour deposition, electro deposition, sol-gel synthesis, ball milling.

Carbon Nanotube: Types of nanotubes, Properties and applications, formation of nanotubes, Synthesis of CNT-Arc discharge, Laser Ablation, Chemical Vapour Deposition (CVD), characterization of nanomaterials and nanostructured materials: Microscopy -SEM, TEM, STEM, AFM, Spectroscopy- XRD, FTIR.   **08 Hours**

Course Outcomes:

Upon the completion of the course, the students will be able to,

- Describe the necessity of composite materials in various fields of applications and its micromechanics.
- Apply the skills of effective production methods of powder metallurgy.
- Distinguish different types of high temperature resistance materials, properties, microstructure and application.
- Analyze different methods of surface coating for best surface finishing process.
- Interpret various nano materials and preparation methods, utilization and understanding the necessity of nano materials.

Text Books:

1. SeropeKalpakjain and Steven R. Schmid: "Manufacturing Engineering and Technology", Pearson Publication, 4th Edition, 2009, ISBN: 978-81-317-0245-1.
2. William D. Callister: "Materials Science and Engineering-an introduction", John Wiley and Sons, 4th Edition, 2012, ISBN: 1118061608.
3. James F.Shackleford, M K Muralidhara: "Introduction to Materials Science for Engineers", Pearson Publication, 6th Edition, 2007, ISBN: 978-81-317-0090-7.

Reference Books:

1. Alan Cottrell: "An Introduction to Metallurgy ", Universities Press, 2nd Edition, 1990, ISBN: 8773712395.
2. Mick Wilson, KamaliKannangara: "Nanotechnology–Basic Science and Emerging Technologies", New South Wales Press Limited, 2nd Edition, 2002, ISBN: 1420035231.
3. V Raghavan: "Physical Metallurgy", PHI, New Delhi ,2nd Edition, 2006, ISBN 13:9788120330122

E Recourses:

1. https://nptel.ac.in/courses/101104010/
2. https://nptel.ac.in/courses/101106038/5
3. https://nptel.ac.in/courses/118102003/

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Additive Manufacturing

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET443	3:0:0:0	3	CIE:50 SEE:50	3 hours	PEC

Course Objectives:

This course will enable students to :

- Understand the role of basic knowledge of additive manufacturing in product development.
- Introduce fundamental principle and working of selective sintering and Fusion Deposition Modeling.
- Educate students about various methods of solid ground curing.
- Conceive, design, and implement products quickly and effectively, using the latest rapid prototyping methods and CAD/CAM technology.
- Differentiate various process parameters associated with Rapid manufacturing techniques.

Syllabus

Module – I

Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems.

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.   **06 Hours**

Module – II

Selective Laser Sintering and Fusion Deposition Modeling: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter, Path generation, Applications.

08 Hours

Module – III

Solid Ground Curing: Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.   **08 Hours**

Module – IV

Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer. GenisysXs printer HP system 5, object Quadra systems.

RP Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.   **08 Hours**

Module – V

Rapid Tooling: Indirect Rapid tooling -Silicone rubber tooling –Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting

tooling, Laminate tooling soft Tooling vs. hard tooling.   **09 Ho**

Course Outcomes:
The students should able to
- Understand and use techniques for processing of CAD models for rapid prototyping.
- Apply fundamentals of rapid prototyping techniques in product development. Identify various rapid prototyping techniques for reverse engineering.
- Implement RP techniques for specific application leading to better ROI for the company that uses RP machines.
- Use appropriate tooling for rapid prototyping process.

Text Books:
1. Gibson D W Rosen, Brent Stucker, "Additive Manufacturing Technologies", Springer Publication, 2nd Edition, 2015, ISBN: 978-1441911216.
2. Chua C.K, Leong K.F and C.S. Lim, "Rapid Prototyping: Principles and Applications in Manufacturing", World Scientific Publishing Ltd, 3rd Revised edition, 2008, ISBN: 978-9812778987.
3. Kamrani A K and Nasr E A, "Rapid Prototyping: Theory and practice", Springer Publication, 1st Edition, 2006, ISBN: 978-0387232904.

Reference Books:-
1. Rafiq I. Noorani , "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons. Publication,1st edition, 2005, ISBN-13: 978-0471730019.
2. Frank W. Liou, "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press,1 edition, 2007, ISBN: 978-0849334092.
3. Andreas Gebhardt, "Additive Manufacturing: 3D Printing for", 4th edition, 2013.

E- Resource
1. https://nptel.ac.in/courses/112104204/47.
2. https://nptel.ac.in/courses/112102103/16.

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Renewable Energy Resources

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET451	3:0:0:0	3	CIE:50 SEE:50	3 hours	PEC

Course Objectives:

This course will enable students to :

- Provide information of the present energy scenario.
- Get insight knowledge of solar radiation geometry and various measurement techniques.
- Understand the solar energy through solar thermal devices.
- Gain knowledge of various renewable energy sources.
- Disseminate information of energy from biomass and hydrogen energy.

Syllabus

Module – I

Introduction: Energy source, India's production and reserves of commercial energy sources, types of energy resources need for non-conventional energy sources, energy policies of India.

Solar Radiation: Extra-Terrestrial radiation, spectral distribution of extraterrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data.

Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working. **08 Hours**

Module – II

Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time. Apparent motion of sun, day length, numerical examples.

Radiation Flux on a Tilted Surface: Beam, diffuse and reflected radiation, expression for flux on a tilted surface (no derivations), numerical examples.

Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid) (Quantitative analysis). **08 Hours**

Module – III

Performance Analysis of Liquid Flat Plate Collectors: General description, collector geometry, selective surface (qualitative discussion) basic energy-balance equation, stagnation temperature, transmissivity of the cover system, transmissivity – absorptivity product, numerical examples. The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss coefficient, problems (all correlations to be provided). Temperature distribution between the collector tubes, collector heat

removal factor, collector efficiency factor and collector flow factor, mean plate temperature, instantaneous efficiency (all expressions to be provided). Effect of various parameters on the collector performance; collector orientation, selective surface, fluid inlet temperature, number covers, dust. **09 Hours**

Module – IV
Photovoltaic Conversion: Description, principle of working and characteristics, applications.

Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind, major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills.

Tidal Power: Tides and waves as energy suppliers and their mechanics, fundamental characteristics of tidal power, harnessing tidal energy, limitations.

Ocean Thermal Energy Conversion: Principle of working, Rankine cycle. **08 Hours**

Module – V
Energy from Bio Mass: Photosynthesis, photosynthetic oxygen production, energy plantation, bio gas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of bio-gas, problems involved with bio-gas production, application of bio-gas, application of bio-gas in engines, advantages.

Hydrogen Energy: Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production bio-chemical production. **07 Hours**

Course Outcomes:
Upon the completion of the course, the student should be able to,
- Explain the present energy scenario and the available Renewable Energy Resources.
- Describe the basics of solar radiation geometry and various measurement techniques.
- Analyze the knowledge gained in tapping the solar energy through solar thermal devices, photovoltaic conversion and their performance analysis.
- Demonstrate the various energy conversion methods such as Wind, Tidal, OTEC.
- Apply knowledge of Biomass and Hydrogen energy and their impact on environment and sustainability.

Text Books:
1. G D Rai: "Non-Conventional Energy Sources", Khanna Publishers, 5thEdition, 2011, ISBN-13: 9788174090737.
2. John Twidell and Tony Weir: "Renewable Energy Resources", Routledge

Publisher, 3rd Edition, 2015, ISBN-13: 978041558437.
3. N K Bansal: "Non-Conventional Energy Resources", Vikas Publishing, 2014, 1st Edition, ISBN-13: 978935978577.

Reference Books:
1. B H Khan: "Non-Conventional Energy Resources", Tata McGraw-Hill Pub., 2nd Edition, 2006, ISBN-13: 9780070142763.
2. S P Sukhatme, J K Nayak: "Solar Energy", Tata McGraw-Hill Pub., 3rd Edition, 2008, ISBN-13: 9780070260641
3. David Craddock, "Renewable Energy Made Easy: Free Energy from Solar, Wind, Hydropower, and other alternate sources", Atlantic Publishing Group, 2008, ISBN-10: 9781601382405

E-Resources:
1. https://nptel.ac.in/courses/112104225/22
2. https://swayam.gov.in/nd1_noc19_ch26/preview

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Management Information System

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET452	3:0:0:0	3	CIE:50 SEE:50	3 hours	PEC

Course Objectives:

This course will enable students to **:**

- Effectively use and administrate information systems in different business applications.
- Understand problem solving techniques to model information system solutions for business problems.
- Understand the usage of intranet and extranets in management information systems.
- Analyze the principles of Transaction Processing Systems.
- Understand the business and professional responsibilities related to the use of information system in Organizations.

Syllabus

Module – I

Foundations of information systems in business: Introduction to Information Systems in Business: Why study Information Systems?, What you need to know, A global Information society, Success and Failure with IT, Why Businesses need Information Technology. Fundamentals of Information Systems: Fundamental Information System concepts: System concepts, Components of an Information System, Information System Resources, Information System activities, Overview of Information Systems: The expanding Role of Information Systems, Operations support Systems, Management support Systems, Other classifications of Information Systems. **10 Hours**

Module – II

Solving Business Problems with Information Systems: A Systems Approach to problem Solving: The Systems approach, Defining problems and opportunities, Developing alternative solutions, Evaluating Alternative solutions, Selecting the best solution, Using the Systems approach. Developing Information System Solutions: The system development cycle, Starting the Systems Development process, Systems Analysis, Systems Design, Prototyping, Implementing a new Information System, Maintenance of Information System, Computer Aided Systems Engineering, End user development. Business applications –I The Internet, Electronic Commerce and Business: Introduction, Business use of the Internet, Interactive marketing, Business value of the Internet, Customer value and the Internet. Fundamentals of Electronic Commerce: Introduction, Foundations and applications of e-commerce, Business to Consumer and Business to Business com-merce, Electronic payments and security.

10 Hours

Module – III

Intranets, Extranets, and Enterprise Collaboration: Intranets and Extranets in Business:

Business Value, Applications and Technologies for Intranets, Role of Extranets, Enterprise Collaboration Systems: Enterprise Collaboration, Group Ware, Electronic communication and Conferencing tools, collaborative work management tools. Information Systems for Business Operations: Business Information Systems: Cross Functional Marketing, Manufacturing, Human Resources, Accounting and Financial Information Systems. **10 Hours**

Module – IV

Transaction Processing Systems: Transaction Processing, Data entry, Batch and Real-time processing, Database maintenance, Document and Report generation, Inquiry processing.

Information Systems for Strategic Advantage: Introduction, Competitive strategy, Strategic Roles for Information System, Breaking Business Barriers, Value chain and strategic Information System, Strategic Applications and Issues in information Technology, Re-engineering Business process, Improving Business quality, Becoming an agile competitor. Creating a virtual Company, Building the knowledge-creating company, Using the Internet Strategically. **11 Hours**

Module – V

Managing information technology: Enterprise and global Management: Managing Information Resources and Technologies: Information Technology Architecture, Managers and Information Technology, Organizations and Information Technology, Information Resource Management, Strategic Management Operational Management, Resource Management, Technology Management, Global Information Technology Management: The International Dimension, Global IT Management, Cultural, Political and Geo-Economic challenges, The global company, Global Business and IT strategies, Global Business and IT applications, Global IT Platforms, Global data Issue, Global Systems development, You and Global IT Management, Planning. Implementing change: Planning for Business change with IT: Organizational planning, Information System planning Methodologies, The scenario approach, planning for competitive advantage, Critical success factors, Business Systems Planning, Computer Aided Planning tools, implementing business change. **11 Hours**

Course Outcomes:

On completion of this course, the students are able to :
- Describe the roles and functionalities of information system.
- Analyze types of solutions for business and its applications.
- Apply Intranet and Extranet in business applications.
- Describe database management and competitive strategic approach of information systems in business applications.
- Describe various approaches in managing information technology.

Text Books:
1. James O'brien, George Marakas: "Management Information System", 10th Edition, McGraw Hill Education, 2010, ISBN-13: 978-0-07-337681-3, ISBN: 0-07337681-7.
2. M V Gandhi, B S Thomson: "Smart Materials and Structures", 1st Edition, Chapman and Hall Pub., 1992, ISBN-13: 9780412370106.
3. Jane Laudon, "Management Information Systems", 5th edition, 2009

Reference Books:
1. Kenneth C. Laudon and Jane P. Laudon: "Management Information System, Managing the Digital Firm", 11th Edition, Pearson Education, 2006.
2. Steven Alter: "Information Systems-The Foundation of E-Business", 4th Edition, Pearson Education, 2002.
3. Paige Baltzan, "Business Driven Information Systems", 6th edition, 2019

E-Resources:
1. https://books.google.co.in/books/about/Management_Information_System.html.
2. http://www.pearsoned.co.uk/bookshop

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Environmental Air Pollution

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET453	3:0:0:0	3	CIE:50 SEE:50	3 hours	PEC

Course Objectives:

- The fundamentals of air pollution with a background on historical perspective on air pollution and current air quality policies and standards.
- Major air pollutants, their sources and their effects (environmental, economic and health) and how emissions are estimated from road traffic and industrial sources.
- Dispersion of air pollutants in the atmosphere.
- Analyze and present outputs of air quality models to a wide range of audiences.
- Different air quality monitoring equipments.

Syllabus

Module – I

Introduction: Definition – Classification and Characterization of Air Pollutants, Emission Sources, Behavior and Fate of air pollutants, Chemical Reactions in the Atmosphere, Photo-chemical Smog, Coal-induced Smog.

Effects of Air Pollution: On Human Health, Animals, Plants and Materials – Major Environmental Air Pollution Episodes–London Smog, Los Angeles Smog and Bhopal Gas Tragedy. **08 Hours**

Module – II

Meteorology: Introduction – Meteorological Variables, Primary and Secondary Lapse Rate, Inversions, Stability Conditions, Windrose, General Characteristics of Stack Plumes, Meteorological Models. Factors to be considered in Industrial Plant Location and Planning, Noise pollution sources, measurement units, effects and control.

10 Hours

Module – III

Sampling, Analysis and Control: Sampling and Measurement of Gaseous and Particulate matter, Stack Sampling, Analysis of Air Pollutants, Smoke and Smoke Measurement.

Air Pollution Control Methods: Particulate, Emission Control, Gravitational Settling Chambers, Cyclone Separators, Fabric Filters, Electrostatic Precipitators, Wet Scrubbers, Selection of a Particulate Collecting Equipment. **10 Hours**

Module – IV

Control of Gaseous Emissions, Adsorption by Liquids, Adsorption by Solids, Combustion Odors and their control.

Air Pollution due to Automobiles: Air Pollution due to Gasoline Driven and Diesel Driven Engines, Effects, Direct and Indirect Methods of control. **10 Hours**

Module – V

Burning Environmental Issues: Acid Rain, Global Warming, Ozone Depletion in Stratosphere, Indoor Air Pollution.

Environmental Legislation: Environmental Policy, Environmental Acts, Water, Air and Noise Pollution Standards.   **10 Hours**

Course Outcomes:

On completion of this course, the students are able to :
- Examine emission standards for industrial and other sources.
- Identify air pollution concentrations as a function of emission, meteorology, topography and the built environment.
- Discuss impact of air pollution on health of humans, animals, plants and materials.
- Identify different equipments for air quality monitoring and control.
- Distinguish between global and local effects of air pollution as well to recognize the legal aspects associated with air pollution.

Text Books:
1. RaoM.N. and RaoH.V.N:"Air Pollution", Tata- McGraw- Hill Publishing CompanyLtd.,New Delhi, India, 2011,ISBN 13:978-0074518717.
2. AnjaneyuluY:"Air Pollution and control Technologies", Allied Publishers, Delhi, 2012, ISBN- 13: 9788177641844.
3. Rao C.S: "Environmental Pollution Control Engineering", New age International Publishers, New Delhi, 2nd Edition, 2013, ISBN- 13: 978-8122418354.

Reference Books:
1. Gilbert M Masters: "Introduction To Environmental Engineering and Science", Pearson Education,3rd Edition,2007,ISBN-13:978-0131481930.
2. Mahajan.S.P:"Pollution Control in Process Industries" Tata Mc-GrawHillPublishing Co.,New Delhi,2010,ISBN-13:978-0074517727.

E-Resources:
1. http://nptel.ac.in/courses/105102089/
2. http://nptel.ac.in/courses/105104099/
3. nptel.ac.in/courses/103107084/module1/lecture1/lecture1.pdf

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Machine Shop Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEL46	0:0:4:0	2	CIE:50 SEE:50	3 hours	PCC

Course Objectives:

This course will enable students to:

- Understand the various types of Lathe, shaping and planning operations
- Conduct and operate the machines to obtain desired shape and size.
- Study concept of milling operations and indexing mechanism.
- Find the method of making slots / keyways using shaping machine.
- Know the eccentric turning and use of 4 jaw chuck.

Syllabus

PART A

Lathe Machine Operations: Preparation of three models on Lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning, jobs involving 3 jaw and use of 4 jaw chuck.

PART B

Milling Machine Operations: Cutting of Spur Gear Teeth (gear tooth calculation).
Shaping Machine: Cutting of V and Rectangular Grooves.

Course Outcomes:

Upon the completion of the course, the students will be able to,

- Describe the knowledge and the skills required with respect to the operation, procedure, conduction and analyzing the results of experiments.
- Demonstrate the operations in Lathe and Drilling machines.
- Analyzing the operations on milling machines.
- Demonstrate the operations on shaping machines.
- Analyzing the use of 4 jaw chuck.

Conducting Classes: Classes may be conducted in one slot per week, of 3 Hours
(Instruction 1 hr. + Conduction and Calculation 2 hr.)

Scheme of Examination:

ONE question from part -A: 30 Marks
ONE question from part -B: 10 Marks
Viva -Voce: 10 Marks

TOTAL : 50 Marks

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Constitution of India, Professional Ethics and Human Rights

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEH47	1:0:0:0	1	CIE:50 SEE:50	2 hours	HSS

Course Objectives:

This course will enable students to understand:

- The basic information about Indian constitution.
- The fundamental rights and duties of a citizen.
- Special privileges of socially and economically weaker sections of the society.
- Individual role and ethical responsibility towards society.

Syllabus

Module – I

Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution, Fundamental Rights & its limitations. **03 Hours**

Module – II

Directive Principles of State Policy & Relevance of Directive Principles of State Policy, Fundamental Duties. Union Executives – President, Prime Minister, Parliament, Supreme Court of India. **03 Hours**

Module – II

State Executives – Governor, Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42nd , 44th , 74th , 76th , 86th& 91st Amendments. **02 Hours**

Module – IV

Special Provision for SC & ST, Special Provision for Women, Children & Backward Classes, Emergency Provisions. Human Rights- Working of National Human Rights Commission in India, Powers and functions of Municipalities, Panchayats and Co - Operative Societies. **03 Hours**

Module – V

Scope & Aims of Engineering Ethics, Responsibility of Engineers, Impediments to Responsibility. Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering. **02 Hours**

Course Outcomes:

On completion of this course, students will be able to:

- Familiarize with fundamental rights and duties.
- Recognize the Electoral Process

- Get exposed to legislature and judiciary
- Realize special provisions given for women, children and weaker section of society
- Exhibit Engineering ethics and responsibilities of Engineers.

Text Books:
1. Durga Das Basu, "Introduction to the Constitution of India", Lexis Nexis Publications; 22nd edition, 2015, ISBN-13: 978-9351434467
2. Charles E. Haries, Michael S Pritchard and Michael J. Robins, "Engineering Ethics", Thomson Wadsworth, 2nd edition, 2003, ISBN-13: 978-9812436764

Reference Books:
1. M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002, 1st edition, ISBN-13: 978-8125918325
2. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", PHI Learning Private Limited-New Delhi, 2nd edition, 2013, ISBN-13: 978-8120348165
3. Brij Kishore Sharma, "Introduction to the Constitution of India", PHI Learning Private Limited-New Delhi, 7th edition, 2015, ISBN-13: 978-8120350892

E-Resources:
1. http://www.cgsird.gov.in/constitution.pdf
2. http://indiacode.nic.in/coiweb/welcome.html

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Environmental Studies

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEH48	1:0:0:0	1	CIE:50 SEE:50	3 hours	HSMC

Course Objectives:

This course will enable students to:

- Critically examine all sides of environmental issues
- Create informed opinions about how to interact with the environment on both a personal and a social level.
- Recognize the physical, chemical, and biological components of the earth's systems.
- Develop a better sense of not only individual organisms, but of the systems in which these organisms live.
- Understand the importance of independent research on human interactions with the environment.

Syllabus

Module – I

Origin of Earth and System processes:- Solar system formation and planetary differentiation; formation of the Earth: formation and composition of core, mantle, crust; chemical composition of Earth; geological time scale and major changes on the Earth's surface; Holocene and the emergence of humans. Concept of plate tectonics and continental drift theory, continental collision and formation of the Himalaya; ocean floor spreading; mantle convection and, major plates; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; paleontological evidences of plate tectonics.   **08 Hours**

Module – II

Minerals and rocks:- Minerals and important rock forming minerals; rock cycle: nitrification and metamorphism; Three rock laws; rock structure, igneous, sedimentary and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: physical processes of erosion, factors affecting erosion; agents of erosion: rivers and streams, glacial and aeolian transportation and deposition of sediments by running water, wind and glaciers.   **09 hours**

Module – III

Earth surface processes:- Atmosphere: evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere–ocean interface, atmosphere–land interface, ocean–land interface; land surface processes: fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes;

coastal processes.   **09 Hours**

Module – IV
Importance of being a mountain:- Formation of Peninsular Indian mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis, etc. Formation of the Himalaya; development of glaciers, perennial river systems and evolution of monsoon in Indian subcontinent; formation of Indo-Gangetic Plains, arrival of humans; evolution of Indus Valley civilization; progression of agriculture in the Indian subcontinent in Holocene; withdrawing monsoon and lessons to draw.   **08 Hours**

Module – V
High Energy Rate forming Methods: Principles, advantages, applications of Explosive forming, Electro hydraulic forming and Electromagnetic forming.
Powder metallurgy: Basic steps in Powder metallurgy, Production of metal powders, Blending metal powders, Compaction, Sintering and Finishing, Application, advantages and limitations of powder metallurgy.   **08 hours**

Course Outcomes:
Upon the completion of the course, the student should be able to,
- Intellectual Flexibility- Students will possess the intellectual flexibility necessary to view environmental questions from multiple perspectives, prepared to alter their understanding as they learn new ways of understanding.
- Problem Solving- Students will solve problems systematically, creatively, and reflexively, ready to assemble knowledge and formulate strategy.
- Interdisciplinary - When encountering environmental problems students will assess necessary scientific concepts and data, consider likely social dynamics, and establish integral cultural contexts.
- Research - When faced with questions that lie beyond their current knowledge base, students will actively research data, concepts, histories, and narratives necessary for adequate consideration of the issue.
- Communication - Students will communicate with precision, effective art, and sound rhetoric in writing, in speech, and in digital media

Text Books:
1. Keller, E.A. 2011. Introduction to Environmental Geology (5th edition). Pearson Prentice
2. Hall. Krishnan, M. S. 1982. Geology of India and Burma. CBS Publishers•& Distributors.

Reference Books:

1. Bridge, J. &Demicco, R. 2008. Earth Surface Processes, Landforms and Sediment deposits. Cambridge University Press.
2. Duff, P. M. D. and Duff, D. (Eds.). 1993. Holmes' Principles of Physical Geology. Taylor•& Francis.
3. Gupta, A. K., Anderson, D. M.,•&Overpeck, J. T. 2003. Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. Nature 421: 354-357

E-Resources:

1. http://www.nptel.ac.in/downloads/112105127
2. http://nptel.ac.in/video.php?subjectId=112105126

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Aadalitha Kannada and Vyavaharika Kannada

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEH49	1:0:0:0	1	CIE:50 SEE:50	3 hours	HSMC

Course Objectives:

The course will enable the students to understand Kannada and communicate in Kannada language.

Syllabus

Module – I

Vyavahari kakannada – Parichaya (Introduction to Vyavaharika Kannada).

Module – II

Kannada Aksharamalehaa guuchcharane(KannadaAlpabets and Pronunciation).

Module – III

Sambhashanegaagi Kannada Padagalu (Kannada Vocabulary for Communication).

Module – IV

Kannada Grammar in Conversations (Sambhashaneyalli Kannada Vyakarana).

Module – V

Activities in Kannada.

Course Outcomes:

At the end of the course, the student will be able to understand Kannada and communicate in Kannada language

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Machine Design

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET51	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Understandthedifferencesbetweendesignandanalysisandintroductionto fundamental notations and approaches to design.
- Learn fundamental approaches to failure, prevention for static and repeated loading.
- Studythecomponentbehaviourforfatigueorfluctuatingloadandtodesign the components for fatigue.
- Study of power necessary for driving power screws at different speeds and torques. Understand the concepts of different stresses in curved beams
- Design of specific machine elements like keys and shafts by applied analysis technique

Syllabus

Module – I

Introduction: Basic procedure of machine design, basic requirement of machine elements, design of machine elements, traditional design methods, Design considerations: codes and Standards, Stress Analysis, selection of material, mechanical properties of materials, Definitions: normal, shear, biaxial and tri axial stresses, Stress tensor, Principal Stresses, Static Strength, Static loads and factor of safety. **08Hours**

Module – II

Theories of Failure and Stress Concentration: Introduction to theories of elastic failure Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials. Selection and use of failure theories, Stress concentration, reduction of stress concentration, Determination of Stress concentration factor for axial, bending, torsion and combined loading.

Impact loads: Introduction, Impact stresses due to axial and bending. **10Hours**

Module – III

Design for Fatigue Load: Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Endurance limit modifying factors: size effect, surface effect, Stress concentration effects; Fluctuating stresses, Goodman and Soderberg relationship; stresses due to combined loading, cumulative fatigue damage.

08Hours

Module – IV

Power Screws: Need of power screws, Advantages and disadvantages, types of threads and their applications, terminology of power screws, Mechanics of power screw(torquerequiredtoriseandlowertheload),Stressesinpowerscrews,efficiency and self-locking, Design of Power Screw.

Curved Beams: Difference between straight and curved beams, Stresses in curved beams of standard cross sections used in crane hook, punching Presses &clamps.

10Hours

Module – V

Design of shafts: Torsion of shafts, design for strength and rigidity with steady load, types of shafts, properties of shaft material, heat treatment of shaft, methods of manufacturing shafts, ASME codes for power transmission shafting, forces acting on the shaft due to belt drive.

Keys: Introduction, functions of keys, Types of keys, specifications of keys, selection of keys Design of keys.**08Hours**

Course Outcomes:

On completion of this course, the students will be able to:
- Analyze the stress and strain on mechanical components and understand, identify and quantify failure modes for mechanical parts.
- Describe the concepts of failure theories and the components subjected to impact load and apply them in machine design.
- Estimate safety factors of simple structures exposed to static and repeated loads.
- Visualize the effect of power screws.
- Know the keys and shafts for rotating machinery.

Design Data Hand Books:
1. Design Data Hand Book – K. Lingaiah, McGraw Hill, 2nd Ed.2003.
2. Design Data Hand Book by K. Mahadevan and BalaveeraReddy, CBSPublication
3. Machine Design Data Hand Book by H.G.Patil, ShriShashi Prakashan,Belgaum.

Text Books:
1.Joseph E Shigley and Charles R. Mischke, "Mechanical Engineering Design",Tata

McGraw Hill Publishing Company Ltd., New Delhi, 8th Edition, 2008 .ISBN-978-0-07-066861-4.

2. V.B. Bhandari, "Design of Machine Elements",Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition 2013 .ISBN-978-0-07-068179-8.

3. J.B.K. Das, P.L.Srinivasa Murthy, "Design of Machine element", Sapana book house, 4th addition, 2018.

Reference Books:

1. Robert L. Norton "Machine Design", Pearson Education Asia, 2nd Edition 2000.ISBN-978-0-07-014480-4.

2. M.F.Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram and C.V. Venkatesh, "Design of Machine Elements", Pearson Education, 8th Edition 2006 ISBN-81-7758-421-9.

3. Sharma, purohitc, sandkamalesh,"DesignofMachineElements", Pearson publications New Delhi 2nd Edition 2003.ISBN-81-203-1955-9.

E-resources:

1. http://nptel.ac.in/courses/112105124/.

2. https://ocw.mit.edu/courses/mechanical-engineering/2-72-elements-of-mechanical-design.

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Dynamics of Machines

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET52	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Learn the principle of static and dynamic force on different mechanisms.

- Understand the concept of friction in different bearings and parameters of belt drives.

- Know the balancing of rotating masses.

- Expose the application and parameters of governors.

- Gain basic knowledge of gyroscopic effect on different vehicles.

Syllabus

Module – I

Static Force Analysis: Introduction: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams. Principleofvirtualwork.Staticforceanalysisoffourbarmechanismsandslider-crank mechanism without friction and numerical on force analysis.   **08Hours**

Module – II

Friction and Belt Drives: Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings, friction factor. Belt drives: Flat belt drives. Ratio of belt tensions, Length of belt drives, centrifugal tension, power transmitted, numerical.
                                        08Hours

Module – III

Balancing of Rotating Masses: Static and dynamic balancing. Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes and numerical.   **08Hours**

Module – IV

Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, Stability, sensitiveness of governors. Isochronisms, effort and power of governors and numerical.   **08Hours**

Module – V

Gyroscope: Victorial representation of angular motion. Gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aeroplane, stability of two wheelers and four wheelers and numerical. **08Hours**

Course Outcomes:

On completion of this course, the students are able to:

- Carry out static force analysis on different mechanisms.
- Find the friction and various parameters of bearings and belt drives.
- Solve the problems on balancing of rotating masses in same and different planes.
- Explain and solve simple problems related to the different governors.
- Determine gyroscopic effect on different vehicles.

Text Books:

1. Sadhu Singh, "Theory of Machines", Pearson Education, 2ndEdition, 2007, ISBN-13: 9788131760697.

2. Rattan S.S., "Theory of Machines", Tata McGraw Hill Publishing Company Ltd, New Delhi, 3rdEdition, 2009, ISBN-13:9780070144774.

3. J.S.Brar, R.K. Bansal, "Theory of Machines", Lakshmi Publication Ltd, New Delhi, 3rdEdition, 2004, ISBN-13:9788131808054.

Reference Books:

1. J.J. Uicker, G.R.Pennock, J.E. Shigley, "Theory of Machines & Mechanisms", Oxford   Publication, 3rd edition, 2009, ISBN-13:9380198062325.

2. A.G.Ambekar,   "Mechanism   and   Machine   Theory", PHI, 2009, ISBN-13:9788131560697.

3. R. S. Khurmi, J.K. Gupta, "Theory of Machines", Eurasia publication house Ltd, 3rdEdition, 2004, ISBN-10:812192524X.

E-resources:

1. http://nptel.ac.in/courses/112104114/http

2, https://cosmolearning.org/courses/dynamics-of-machines/video-lectures/

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Artificial Intelligence and Robotics (IC)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEI53	3:0:2:0	4	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:
- Understand the role of knowledge representation, problem solving and learning methods of AI in robotics.
- Know the parts of robots, types of robots and basic mathematical concepts related to design of robot.
- Study the concept of statics and kinematics of robot manipulator along with velocity analysis.
- Develop the dynamics of manipulator and trajectory planning.
- Impart the conceptual idea of various drive systems for robot, sensors, actuators and their applications in robots and programming of robots.

Syllabus

Module – I

Introduction to Artificial Intelligence: Definition, goals of AI research, importance of AI and AI related fields, Goals of AI research, AI techniques, knowledge representation, techniques for representing knowledge, logic, procedural representation, semantic network, production systems, other representation techniques, problem representation and problem solving, search techniques in problem solving, LISP programming, AI and Robotics, LISP in the factory.   **06 Hours**

Module – II

Introduction and Mathematical Representation of Robots: Types of Robots, End Effectors, Notation, Position and Orientation of a Rigid Body, Some Properties of Rotation Matrices, Successive Rotations, Euler Angles for fixed frames X-Y-Z and moving frame ZYZ. Representation of Links using Denavit- Hartenberg Parameters: Link parameters for intermediate, Link transformation matrices, Transformation matrices of 3R manipulator, PUMA560 manipulator, SCARA manipulator.   **09Hours**

Module – III

DKandIK of manipulators: Degree of freedom of manipulator, Direct kinematics of serial and parallel manipulator, Inverse kinematics of serial manipulator.

Velocity Analysis and Statics of Manipulators: Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, Jacobian of serial manipulator, Singularities of serial and parallel manipulators. **08 Hours**

Module – IV

Dynamics of Manipulators: Kinetic energy, Potential energy, Equation of motion using Lagrangian, Inertia of a link, Recursive formulation of Dynamics using Newton Euler equation, Equation of motion of 2R manipulator using Lagrangian, Newton-Euler formulation.

Trajectory Planning: Joint space schemes, cubic trajectory, Joint space schemes with via point. **09Hours**

Module – V

Robot Programming: Introduction, Manual teaching, lead through teaching, programming languages, VAL II, simple example of pelletization.

Actuators and Sensors: Types, Characteristics of actuating system: weight, power to- weight ratio, operating pressure, stiffness vs. compliance, Use of reduction gears, comparison of hydraulic, electric, pneumatic actuators, sensor, types of sensor. **08Hours**

List of Experiments
1. Experiment on different types of robots based on configuration and application.
2. Determination of degrees of freedom for robotic arm.
3. Determination of gripping force and actuating force for mechanical gripper.
4. Determination of maximum and minimum position of links.
5. Simulation of different robot motion based on application
6. Robot programming: Using Teach Pendent & Offline programming to perform pick and place Stacking of objects, 2 programs.

Course Outcomes:

On completion of this course, the students are able to:

- Describe the basic knowledge gained in Artificial Intelligence in Robotics.
- Demonstrate the different classes of robot & explain how you to select a specific class of robot for industrial application.
- Evaluate the different industrial robot based on kinematic and dynamic analysis.
- Develop different programming in robotics depending upon application.

- Identify the general type of sensors & actuator associated with industrial applications.

Text Books:

1. Stuart J Russel, Peter Norvig, "Artificial Intelligence", Pearson Education India; 3 Edition, 2017, ISBN:978-9332543517.
2. Ashitava Ghosal, "Robotic Fundamental Concepts and Analysis Oxford University Press, 4th Edition, 2009, ISBN-13:9780195673913.
3. Mikell P Groover, Mitchell Weiss, "Industrial Robotics), Tata McGraw Hill Publications, 2003, ISBN:978-0071004428.

Reference Books:

1. David Cook, "Robot Building for Beginners", 2nd Edition, 2010, ISBN:978-1430227489.
2. Robert J Schilling, "Fundaments of Robotics, analysis and control", Prentice Hall India Learning Private Limited, 2010, ISBN:978-8120310476.
3. Ganesh S Hedge, "Industrial Robotics", 2nd Edition, Laxmi Publications,2015, ISBN-13: 978-8131805183.

E-resources:

1. http://nptel.ac.in/courses/106105077/

2. http://nptel.ac.in/courses/112101099/

3. http://nptel.ac.in/courses/112101098/

4. https://see.stanford.edu/Course/CS223A

5. http://www.vlab.co.in/

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Fluid Mechanics

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET54	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Understand the basic concepts and recognize the various types of fluid flow.
- Study the concept of Euler's equation and extracting Bernoullis's equation for flow measurement.
- Know the reasons for Major and minor loss of energy and Dimensionless Analysis
- Understand the various losses in the fluid flow.
- Learn the concept of Buoyancy.

Syllabus

Module – I

Properties of fluids-Introduction to fluid mechanics & its applications, properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure and cavitations.

Fluid Statics: Fluid Pressure at a Point, Pascal's Law, Pressure variation in a Static Fluid, Absolute, Gauge, Atmosphere and Vacuum Pressure, Manometers, Problems.

08 Hours

Module – II

Fluid Dynamics: Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, Limitation of Bernoulli's equation.

Fluid flow measurements: Introduction, Hydraulic coefficients, Venturimeter, orifice meter, Pitot tube, V-notch and Rectangular notch, Advanced Measuring Devices-Electromagnetic flow meters, Turbine meters, Vortex flow meters, Ultrasonic flow meters, Laminar flow meter, Thermal mass flow meter.   **10 Hours**

Module – III

Flow through pipes: Frictional loss in pipe flow, Darcy's-Equation and Chezy's equation for loss of head due to friction in pipes.

Dimensional Analysis: Introduction, derived quantities, dimensions of Physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham's π theorem, dimensionless numbers and their significance. **08Hours**

Module – IV

Laminar flow and viscous effects: Reynolds experiment, critical Reynolds number, Laminar flow through circular pipe-Hagen poiseulle's equation, Laminar flow between parallel plates.

Fluid Kinematics & Buoyancy: Buoyancy, center of buoyancy, meta center and meta center height, Conditions of equilibrium of floating and submerged bodies. Types of fluid flow-Introduction, Continuity equation in three dimensions (Cartesian co-ordinate system only), velocity and acceleration, velocity potential function and stream function. **09Hours**

Module – V

Introduction to compressible flow: Velocity of sound in a fluid and its expression for isothermal and adiabatic flow. Mach number, Propagation of pressure wave sin a compressible fluid.

Flow past immersed bodies: Drag, Lift, expression for lift and drag, pressure drag and friction drag, boundary layer concept, displacement thickness, momentum thickness and energy thickness. **08Hours**

Course Outcomes:

On completion of this course, the students are able to:
- Identify the type of fluid also able to apply Pascal's law in problems and they should realize the function of manometers.
- Apply the Bernoulli equation to solve problems in fluid mechanics and can demonstrateaboutfluidflowmeasuringdevicesanditsareasofapplications.
- Analyze the reason for energy losses in pipes and ability to perform dimensional analysis for problems in fluid mechanics.
- Demonstratethedistributionofshearstressandvelocityduringlaminarflow.
- Describe the basic concepts viz. buoyancy, floatation, friction in pipe flow, lift and drag.

Text Books:
1. Dr. Bansal R. K, "Fluid Mechanics and Hydraulic Machines", Lakshmi Publicatins, 9thedition, 2017, ISBN-978-81-318-0817-3.
2. Dr. K Subramanya, "Fluid Mechanics and Hydraulic Machines", Tata McGraw Hill Publicatons, 2014, ISBN-978-0-07-069980-9.
3. Dr. Jagadishlal, "Fluid Mechanics and Hydraulics", Metropolitan Book Co-Ltd, 9thedition, 2008, ISBN-978-8120004221.

Reference Books:

1. P.N. Modi and Seth, "Hydraulics and Fluid Mechanics", 20thedition 2013. ISBN-978-8-18-940126-9.
2. Kumar. D. S, Kataria and Sons, "Fluid Mechanics and Fluid Power Engineering", 9thedition 2013. ISBN-978-9350143926.
3. R K Rajpuit, " Fluid Mechanics and Hydraulic Machines", 6th edition 2018, ISBN-13: 978-9385401374

E-resources:

1. http://nptel.ac.in/courses/112105171/1
2. http://nptel.ac.in/courses/112105183/
3. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-01-unified-engineering-i-ii-iii-iv-fall-2005-spring-2006/fluid-mechanics/

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Composite Materials Technology

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET551	3:0:0:0	3	CIE:50SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to:

- Learn the basic concepts of the composite materials.
- Understand the different matrix materials and fabrication techniques of composite materials.
- Gain the knowledge of analysis of composite materials
- Know the different theory of failures micro mechanical lamina
- Study the applications and Testing of composite materials.

Syllabus

Module – I

Introduction to Composite Materials: Historical Background, Definition, need for developing composite materials, Classification of composites, Desirable characteristics of fiber Reinforced Composites, Types of matrices material and reinforcements, Interfaces in composites, Advantages and Disadvantages of composites.   **08 Hours**

Module – II

Matrix Materials: Role of matrix materials, classification, Metal Matrix Composites, Polymer Matrix Composites, Ceramic Matrix Composites, Mechanical properties, advantages, disadvantages, Role of Nano particles in the matrix materials.

Manufacturing: Layup and curing - open and closed mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding.   **08 Hours**

Module – III

Macro Mechanics of a Lamina: Hooke's law for different types of materials, Elastic constants, Derivation of nine independent constants for orthotropic material, Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems

08 Hours

Module – IV

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems.

Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Tsa-Hill theory, Tsai wu theory, Numerical problems. **08 Hours**

Module – V
Testing: NDT tests – Purpose, Types of defects, NDT methods: Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.

Applications: Aircraft, Missiles, Space Hardware, Automobile, Marine, Electrical and Electronics, Recreational and Sports equipment-future potential of composites.

08 Hours

Course Outcomes:
Upon the completion of the course, the student should be able to,
- Recognize the different types of Composite materials.
- Describe the different matrix materials and manufacturing process.
- Analyze composite lamina for different constants in macro level.
- Predict failure of composite materials by using different theories of failures.
- Identify suitable applications and testing for composite materials.

Text Books:
1. Krishan K. Chawla: "Composite Materials and Engineering", Springer (India) Private Limited, 2nd Edition, ISBN: 978-81-8128-490-7.
2. Robert M. Jones: "Mechanics of Composite Materials", Taylor and Francis, 2nd Edition, 2013, ISBN: 1-56032-712-X.
3 MadhijitMukhopadhay, "Mechanics of Composite Materials & Structures', Universities Press, ISBN : SBN: 9788173714771, 9788173714771.

Reference Books:
1. D. Hull and T. W. Clyne: "An Introduction to Composite Materials", Cambridge University Press, 2nd Edition, 2008, ISBN: 978-0-521-73548-3.
2. Madhujit Mukhopadhyay: "Mechanics of Composite materials and Structures", Universities Press, 2013, ISBN: 978-81-7371-477-1.
3. Autar K. Kaw: "Mechanics of Composite Materials", Taylor and Francis, 2nd Edition, 2009, ISBN: 0-8493-1343-0.

E-resources:
1. http://nptel.ac.in/courses/112104168/
2. http://freevideolectures.com/Course/3479/Processing-of-non-metals/5 18

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Power Plant Engineering

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET552	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to:

- Understand the working of steam engine power plant with various part functioning
- Study the function of ash handling system and various boilers
- Learn Diesel Engine Power Plant Function and Power generated by Hydro Electric Power Plant
- Know about Chimneys and Accessories used and Importance of Site Selection
- Study the information about Nuclear Power Generation and Economic Analysis of Generating Power

Syllabus

Module – I

Steam Power Plant: Different types of fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Oil burners, Advantages and Disadvantages of using pulverized fuel, unit system and bin system.   **07Hours**

Module – II

Coal, Ash Handling and Different Types of Boilers: Coal and Ash handling, Generation of steam using forced circulation, high and super critical pressures, A brief account of La Mount, Benson, Velox, Schmidt, Loffler and Ramson steam generators.   **09 Hours**

Module – III

Diesel Engine Power Plant: Method of starting diesel engines, Coolingandlubricationsystemforthedieselengine.Intakeandexhaustsystem, Lay- out of a diesel power plant.

Gas turbine power plant: Principle of working, Components of gas turbine, classification of gas turbine, layout of gas turbine plant

Hydroelectric Power Plant: Hydro-Electric Plants: Storage and pondage, flow duration and mass curves, hydrographs, Low, medium and high head plants, pumped storage plants, Design of Penstock, water hammer, surge tanks.   **08Hours**

Module – IV

Exhaust and Cooling System: Natural, forced, induced and balanced draft, Study of different types of cooling towers and ponds, mechanism of cooling system.

Choice of Site: load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor, Effect of variable load on power plant, geological consideration   **08Hours**

Module – V

Nuclear Power Plant: Principles of release of nuclear energy Fusion and fission reactions. Nuclear fuels used in the reactors. Multiplication and thermal utilization factors.ElementsoftheNuclearreactor,Moderator,controlrod,fuelrods,coolants.Classification of nuclear reactors, pressurized water, trysium water, Boiling water reactor, Heavy water reactor CANDU, Fast breeder reactor. types of nuclear wastes and its disposal. Introduction of Containment structure.

Economic Analysis of Power Plant: Cost of energy production, selection of plant and generating equipment, performance and operating characteristics of power plants

                08 Hours

Course Outcomes:

Upon the completion of the course, the student should be able to,
- Deliver at alkon Steam Engine Power Generation.
- Suggest the best method of Ash handling System and Boiler needed.
- Analyze Power Generated by Diesel Engine and can effectively draw hydrograph and Flow duration curves.
- DemonstratethefunctionsofChimneysandcanexplainroleofsiteselection.
- Explain the functioning of Nuclear Power Generation.

Text Books:
1. Dr. P K Nag, "Power Plant Engineering", Tata McGraw Hill Publications, 3rdEdition, 2009, ISBN- 13:978-0-07-064817-9.
2. R K Rajput, "Power Plant Engineering", Lakshmi Publications, 2009, ISBN- 13:978-81-318-0255.
3. C. Elanchezhian, L. Saravanakumar, B. Vijaya Ramnath "Power Plant Engineering", Wiley, 2019, ISBN: 9789389447378.

Reference Books:
1. Manoj Kumar Gupta, "Power Plant Engineering", PHI publishing,1stEdition, 2012, ISBN: 9788120346123.
2. Skrotizke and V Opat, "Power station Engineering", McGraw-Hill, 2ndRevised Edition, 2012, ISBN: 978-0070579408.
3. D.K. Chavan and G.K. Pathak, "Power Plant Engineering", Rajsons Publications, 2016, ISBN : 978-81-89401-42-9.

E-resources:
1.http://nptel.ac.in/courses/108105058/8http://nptel.ac.in/courses/112106133/15

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Turbo Machines

Course Code	L:T:P	Credits	Exam marks	Exam Duration	Course Type
19MET553	3:0:0:0	3	CIE:50 SEE:50	3 hours	PEC

Course Objectives:

This course will enable students to:

- Understand the comparison of positive displacement turbo machine and energy transfer in turbo machine.
- Know general analysis of utilization factor and axial flow turbo machines.
- Develop design of hydraulic turbines, steam turbines.
- Impart knowledge of centrifugal pumps and stage efficiency, reheat factor and preheat factors in turbines.
- Study working of thermodynamic of fluid flows, design of centrifugal and axial compressors and pumps.

Syllabus

Module – I

Introduction: Definition of a turbo machine, parts of a turbo machine, Comparison with positive displacement machine; Classification; Dimensionless parameters and their physical significance; Effect of Reynolds number; Specific speed; Illustrative examples on dimensional analysis and model studies.

Energy Transfer in Turbo Machine: Euler Turbine equation; Alternate form of Euler turbine Equation, components of energy transfer; Degree of reaction.   **08 Hours**

Module – II

General Analysis of Turbines: Utilization factor, Vane efficiency, Relation between utilization factor and degree of reaction, condition for maximum utilization factor – optimum blade speed ratio for different types of turbines.

General analysis of centrifugal pumps and compressors: General analysis of axial flow compressors and pumps – general expression for degree of reaction, velocity triangles for different values of degree of reaction. Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance,

Theoretical head – capacity relationship. **08 Hours**

Module – III

Hydraulic Turbines: Classification, Pelton Turbine-velocity triangles, Design parameters, turbine efficiency, volumetric efficiency. Francis turbine-velocity triangles, runner shapes for different blade speeds, Design of Francis turbine, Functions of a Draft tube, types of draft tubes, Kaplan and Propeller turbines – Velocity triangles and design parameters. Characteristic curves for hydraulic Turbines, Erosion study.

08 Hours

Module – IV

Steam Turbines: Introduction to steam nozzles and optimum pressure ratio. Impulse Staging and need for compounding, Velocity and pressure compounding, velocity triangle, condition for maximum utilization factor for multistage turbine with equiangular blades, Effects of Blade and Nozzle losses, Reaction staging. Centrifugal Compressors and Axial Flow Compressors: Centrifugal compressors, Main parts and principle of operation power input factor, pre whirl vanes, surging and checking phenomenon. Axial Flow Compressors: Construction and working principle, work done factor and numerical. **08 Hours**

Module – V

Thermodynamics of Fluid Flow: Stagnation and static properties and their relations, Compression process – overall isentropic efficiency of compression, State efficiency, Comparison and relation between overall efficiency and stage efficiency, Polytrophic efficiency, Preheat factor. **Centrifugal Pumps:** Definition of terms used in the design of centrifugal pumps like mano metric head, suction head, delivery head, mano metric efficiency, hydraulic efficiency, volumetric efficiency, overall efficiency, multistage centrifugal pumps design procedure. **08 Hours**

Course Outcomes:
Upon the completion of the course, the student should be able to,

- Describe working and various energy transfer processes in turbo-machines.
- Evaluate the fluid flow in steam and hydraulic turbines.
- Apply the working of Pelton and Francis turbine.
- Demonstrate the working of steam turbines, centrifugal pumps.
- Analyze thermodynamic analysis of fluid flow and centrifugal compressors.

Text Books:
1. V.Kadambi, Manohar Prasad: "An Introduction to energy conversion, Volume III – Turbo machinery", New Age International Publishers (P) Ltd., 2nd Edition, 2011, ISBN: 978- 122431896.
2. G. Gopalakrishnan, D.Prithviraj: "A Treatise on Turbo Machines", Scitech Publications (India) Pvt. Limited, 2nd Edition, 2010, ISBN: 978- 8187328988.

Reference Books:
1. H.Cohen, GFC Rogers, HIH SaravanaMuttoo: "Gas Turbine Theory",Thomson Press (India) Ltd., 4th Edition, 1998, ISBN: 81-297-0486-2.
2. S. M. Yahya: "Turbines, Compressors and Fans",Tata-McGraw Hill Co, 2nd Edition, 2010, ISBN-13: 978007451219912.

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Metal Forming Process

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET561	3:0:0:0	3	CIE:50 SEE:50	3 hours	PEC

Course Objectives:

This course will enable students to:

- Learn the different methods of Metalworking process for different materials.
- Gain the knowledge for various parameters affecting forming process.
- Learn the methods, load determination and various defects in the forging & extrusion process.
- Understand variables, defects occurred during the rolling and sheet metal operations of various Products.
- Learn preparation of powders, Mixing, Compaction and Sintering of various components using Powder Metallurgy.

Syllabus

Module – I

Introduction and Concepts: Classification of metal working processes, characteristics of wrought products, advantages and limitations of metal working processes.

Effects of parameters on metal working: Temperature, strain rate, friction and lubrication, hydrostatic pressure in metalworking, Deformation zone geometry, workability of materials, Residual stresses in wrought products.   **08 hours**

Module – II

Forging: Classification of forging processes. Forging machines &equipments. Forging pressures & load in open die forging and closed die forging by slab analysis (No

derivation), concepts of friction hill and factors affecting it. Die-design parameters. Forging defects, Simple problems.

Extrusion: Types of extrusion processes, Extrusion Equipment & dies, Variables involved in extrusion process, Metal flow pattern in extrusion, Extrusion of Seamless tubes, Defects in extruded products, Simple problem on extrusion forces (No derivation) **09 hours**

Module – III

Rolling: Classification of Rolling processes. Types of rolling mills, Rolling load. Roll separating force, power required in rolling, friction, friction hill, Maximum possible reduction. Defects in rolled products. Rolling variables, simple problems.

Sheet & metal forming: Definition of sheet metal, Material used for sheet metal, Classification of power presses, Sheet metal operations, defects of drawn sheet metal products. **09 hours**

Module – IV

Drawing: Drawing Equipment, Steps involved in wire drawing, Drawing die details, Optimal cone angle & dead zone formation, Redundant work and its estimation, Drawing Variables, Tube drawing processes, Expression for drawing force in wire drawing, Frictionless drawing of cylindrical rod, Applications of Drawing. **08 hours**

Module – V

High Energy Rate forming Methods : Principles, advantages, applications of Explosive forming, Electro hydraulic forming and Electromagnetic forming.

Powder metallurgy: Basic steps in Powder metallurgy, Production of metal powders, Blending metal powders, Compaction, Sintering and Finishing, Application, advantages and limitations of powder metallurgy. **08 hours**

Course Outcomes:
Upon the completion of the course, the student should be able to,
- learn and understand necessity of forming process compared with other manufacturing techniques
- Analyze the stresses, yield criteria and parameters effect on the processing of the wrought products used for the deformation analysis of the process.
- To select the process, load required and possible reasons for the formation defects of the forged & extruded components.
- They should identify the process, load calculations and reasons for the formation defects of the rolled products and parameters for the fabrication of various sheet metal components.

- To select the different high energy rate forming process suitable for fabrication of bulk sheet metal components and to identify the methods used for the various powder metallurgical components.

Text Books:
1. George E. Dieter, "Mechanical metallurgy", Tata McGraw - Hill publication, 4th Edition, ISBN : 0-07-084187
2. Seropekalpakajiam and Steven R Schimid, "Manufacturing Processes for Engineering materials", Pearson education, 4th Edition, 2014, ISBN : 81-7808-990-4 ISBN- 81-317-0245-6
3. Theory of Plasticity and Metal Forming Processes by Dr. Sadhu Singh Khanna Publishers, 2008.

Reference Books:

4. Materials & Processes in Manufacturing *by* Paul Degarmo E, Jt Black, Ronald A Kohser. Prentice -hall of India,8th edition 2006
5. Principles of Industrial metal working process - G.W. Rowe, CBS Publishers. 1st edition 2005
6. Manufacturing Science, by Ashok Kumar Mallik & Amitabha Ghosh - Affiliated East-west Press Pvt Ltd , 2nd edition 2012.

E-Resources:
3. http://www.nptel.ac.in/downloads/112105127
4. http://nptel.ac.in/video.php?subjectId=112105126

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Mechatronics

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET562	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to :

- Appreciate the evolution and development of Mechatronics as a discipline.
- Elucidate the application of sensors and transducers in the design of mechatronic systems
- Know the use of various electrical actuators, signal conditioners and filters
- Demonstrate the knowledge of applications of microprocessors
- Work efficiently in multidisciplinary teams.

Syllabus

Module – I

Introduction to Mechatronics: Introduction of Mechatronics systems, Evolution on Mechatronics, Measurement system, control systems, micro processor based controllers, Mechatronics system design approach Automatic washing machine, automatic camera and Engine management system, Mechatronics approach and their associated problems. Examples and discussion on typical systems.   **08 Hours**

Module – II

Transducers and Sensors: Introduction of Transducers, Classifications, Potentiometer, Capacitive Sensor, Eddy current proximity sensor, Hall effect sensor, Temperature sensor, light sensors, selection of sensors, inputting data by switches, Strain gauge and Wheat Stone Bridge**,** Data Analysis.   **08 Hours**

Module – III

Electrical Actuation Systems: Electrical systems, Mechanical switches, solid state switches, DC and AC motors, stepper motors and their merits and demerits. Signal

conditioning: Introduction to signal conditioning. The operational amplifier, Protection, Filtering, Wheatstone bridge, digital signals Multiplexers, data acquisition, Introduction to Digital system processing pulse modulation. **08 Hours**

Module – IV

Introduction to Microprocessors: Evaluation of Microprocessor, Organization of Microprocessors, basic concepts of programming of microprocessors. Review of concepts- Boolean algebra, Logic Gates and gate networks, binary and decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation.

08 Hours

Module – V

Data & Word Representation: Basic elements of control systems, 8085A processor architecture terminology such as CPU, Memory and Address, ALU, Assembler, Data Registers, Fetch cycle, Write cycle, State, Bus, Interrupts. Micro Controllers, Requirements for control and their implementation in microcontrollers. Classification of micro controllers.

Assembly Language Programming: 8085 programming, Instructions, Classification, 8085 instruction set, Data format and storage, simple assembly level programming.

08 Hours

Course Outcomes:
At the end of the course, the student will be able to :
- Illustrate various Components of Mechatronics Systems

- Apply the knowledge of sensors and actuators for an engineering application

- Describe the functions of Actuators, Signal Conditioners and Filters

- Recognize the function of Microprocessors and its various elements.

- Draw the architecture of 8085 Microprocessor and write Assembly level programs for simple tasks.

Text Books:
1. R.S. Ganokar, Wiley Eastern: "Microprocessor Architecture, programming and applications with 8085/8085A", Penram International Publication, 6th Edition, 2013, ISBN: 9788187972884.
2. W. Bolton, Longman: "Mechatronics-Electronic control system in mechanical and electrical engineering", Pearson Education, 6th Edition, 2017, ISBN: 9781292076683.
3. NitaigourPremchandMahalik, "Mechatronics-Principles Concepts and Applications", Tata McGraw Hill, ISBN : 0071239243, 9780071239240.

Reference Books:

1. Godfrey C. Canwerbolu: "Mechatronics Principles and applications", Butterworth- Heinemann Publication, 1st Edition, 2005, ISBN: 978-0750663793.
2. David. G. Aliciatore, Michael, B.Bihistand: "Introduction to Mechatronics and Measurement systems", McGraw Hill, 3rd Edition, 2008, ISBN: 978-0-07-064814-2.
3. 3.K.P.Ramachandran, G.K, Vijayaraghavan, M.S Balasundaram, "Mechatronics: Integrated Mechanical Electronic Systems", Wiley India Pvt. Ltd. New Delhi, ISBN-13: 978-8126518371.

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Basics of Python for Mechanical Engineers

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET563	3:0:0:0	3	CIE:50SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to:

- Understand the programming concepts.
- Know the arithmetic & logic operations, data & control transfer operations, input & output operations and looping instructions
- Know flow of air over bicycle with different coefficients with Python Programming
- Analyze the pressure and volume variation in air standard cycles using Python.
- Gain the knowledge of curve fittings for different data collections.

Syllabus

Module – I

Introduction:-Basic concepts. Python applications. Versions. Basic Python syntax, Comments in Python, Triple, double and single quotes, Python back slash. Variables. Data types in Python. Operators.   **08 Hours**

Module – II

Functions:-Stings, Lists, Append, Control statements and Loops. Arrays, Different modules, Numpy, Mathplot, Scipy, Math. Object-oriented programming. Programs using modules.   **08 Hours**

Module – III

Flow over Bicycle: Drag force, drag coefficients for different structures. Velocity of bicycle. Programming for different velocity and coefficients.   **08 Hours**

<div align="center">**Module – IV**</div>

Simulation of air standard cycles:-Pressure, volume and temperature relation in Otto, Diesel and dual cycle. Efficiency. P-V diagrams for different size of engine. Programming and plotting P-V diagrams.   **08 Hours**

<div align="center">**Module – V**</div>

Curve fitting:-Collection of data, fitting for 2nd, 3rd order differential equations, programming.   **08 Hours**

Course Outcomes:

Upon the completion of the course, the student should be able to,

- Recognize the different functions used to write programs.
- Describe the use of stings, loops, arrays and modules in programming.
- Analyze the drag force acting on bicycle over different drag coefficients.
- Plot and Predict salient points in an engine with respect to pressure and volume.
- Collection of data from systems and fit in an order by programming.

Text Books:

1. Mohit Bhaskar N. Das: "Learn Python", Packt Publishing, 1^{st}Edition, 2017, ISBN: 978-1-178728-838-6.
2. Guttag, John V. "Introduction to Computation and Programming Using Python With Application to Understanding Data". 2017. MIT Press. ISBN: 978-0-262-52962-4.
3. 3. Mark Lutz,."Learning Python". O'Reilly, Sebastopol, ISBN: 9781449355739

Reference Books:

1. P. A. Jacobs"Elements of Python3 Programming for Mechanical Engineers", the University of Queensland, 1st Edition, 2015, ISBN: 978-0-521-73548-3.
2. Eric Matthes, "Python Crash Course, 2nd Edition: A Hands-On, Project-Based Introduction to Programming" Starch Press; 2 edition, ISBN-13: 978-1593279288.
3. 3. Christian Hill, "Learning Scientific Programming with Python", Cambridge University Press, ISBN-13: 978-1107428225.

E-resources:

1. http://ocw.mit.edu/terms/
2. https://www.w3schools.com/python/
3. https://www.cs.uky.edu/~keen/115/Haltermanpythonbook.pdf

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Fluid Machinery Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEL57	2:0:0:0	2	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Know the losses in flow through pipes.
- Understand the importance of fluid flow measuring devices.
- Learn the working of turbines.
- Study the performance of pumps and compressors.

Syllabus

PART-A

1. Determination of force developed by impact of jets on vanes.
2. Calibration of v-notch
3. Flow measurement using Rectangular notch
4. Studies on minor losses in pipes
5. Calibration of Venturi and orifice meter
6. Studies on major losses in pipes

PART-B

1. Performance testing of Impulse Water Turbines
2. Performance testing of Reaction Water Turbines
3. Performance study of single stage / multi stage centrifugal pump
4. Performance study of Reciprocating Pump
5. Performance test of a two stage Reciprocating Air Compressor.
6. Performance test on an Air Blower

Course Outcomes:

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

- Describe the friction losses for different diameters of pipes.
- Calibrate various measuring devices in fluid flow measurement.
- Apply the power generation by using turbines.
- Evaluate the performance of compressor and pumps.

Conducting classes:

Classes may be conducted in one slot per week, of 3 hours

(Instruction 1 hr. + Conduction & Calculation 2 hr.)

Scheme of Evaluation

Individual Experiment:15Marks

Group Experiment:25Marks

Viva-voce: 10Marks

Total   : 50 Marks

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Energy Conversion Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEL58	2:0:0:0	2	CIE:50SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Learn the fundamentals of fuels and develop the ability to determine properties like flash and fire point, calorific value and viscosity of fuels through experimentation.
- Understand the concept of Valve and port timing diagrams and their significance in internal combustion engines.
- Develop the ability to conduct experiments to carryout performance testing of various types of internal combustion engines and to evaluate various performance parameters.
- Study the performance of air compressor and air blower and to evaluate related performance parameters.

Syllabus

PART A

1. Determination of Flash point and Fire point of lubricating oil using Pensky apparatus.
2. Determination of Calorific value of solid, liquid and gaseous fuels.
3. Determination of Viscosity of a lubricating oil using Redwoods Viscometers.
4. DeterminationofViscosityofalubricatingoilusingTorsionViscometers.
5. Valve Timing/port opening diagram of anI.C. engine (4stroke/2stroke).

PART B

1. Evaluation of Performance of 2-stroke air cooled, mechanically loaded petrol engine.
2. Evaluation of Performance of 2-stroke air cooled, electrically loaded petrol engine.
3. Evaluation of Performance of 4-stroke air cooled, electrically loaded petrol engine.
4. Morse test on a multi-cylinder engine.
5. Performance testing of 4-stroke diesel engine with heat balance analysis.

Course Outcomes:

Upon the completion of the course, the student should be able to,
- Fundamentalpropertiesoffuelsandexperimentalmethodstodeterminethe values.
- Importance and significance of valve and port timing diagrams in four stroke and two stroke engines.
- Experimental procedure to evaluate various performance parameters of different types of I C engines.
- PerformanceofAircompressorandblowerandtoassessvariousperformance parameters.

Conducting classes: Classes may be conducted in one slot per week, of 3 hours

(Instruction 1 hr. + Conduction & Calculation 2 hr.)

Scheme of Evaluation:

ONE question from part-A: 20Marks

ONE question from part-B: 20Marks

Viva-voce:10Marks

TOTAL: 50 Marks

Finite Element Methods

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET61	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:

- Learn the knowledge on the concept of finite element methods for analysis of structures.
- Study the finite element analysis of bars.
- Educate the students regarding the finite element formulation of 2-D problems.
- Expose the students to Finite element analysis of trusses.
- Learn the finite element analysis of beams.

Syllabus

Module – I

Introduction to Finite Element Methods (FEM): Equilibrium equations in elasticity subjected to body force, traction forces and point loads, plane stress and plane strains problems. Engineering Analysis, definition and history of FEM, basic steps in FEM to solve mechanical problems. Discretization, types of elements based on geometry, Node numbering Scheme, concept of half band width, applications, advantages and limitations of FEM.   **10Hours**

<p style="text-align:center">**Module – II**</p>

Analysis of Bars: Shape function and its properties, Shape function for bar element, Stiffness matrix formulation of bar element, Degree of freedom, Uniform and stepped cross sectional bars. Solutions of uniform bars and stepped bars for displacements, stresses and reactions by using elimination approach and penalty approach. Gauss elimination approach.   **10Hours**

<p style="text-align:center">**Module – III**</p>

Interpolation Models: Interpolation polynomials for Linear, quadratic and cubic elements. Simplex, Complex and Multiplex elements. Convergence requirements, Compatibility condition, Coordinate Systems, PASCAL's triangle. Shape functions of three-noded triangular element, and four-noded quadrilateral element. Serendipity and Lagrange family Elements, Higher order elements, iso-parametric, Sub-parametric and Super parametric elements.   **10Hours**

<p style="text-align:center">**Module – IV**</p>

Analysis of Trusses: Introduction to Trusses**,** assumptions made in analysis of Trusses, Derivation of stiffness matrix, Strain matrix, Stress matrix. Solutions of Truss element for nodal displacements, stresses and support reactions, Types of joints in trusses.   **09 Hours**

<p style="text-align:center">**Module – V**</p>

Analysis of Beams: Introduction, types of beam. Hermite shape functions for beam element. Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, uniform distributed loads.   **09Hours**

Course Outcomes:

Upon the completion of the course, the students will be able to:
- Apply the basic concepts of finite element method and carryout the analysis.
- Realize the importance of finite element analysis of bars.
- DeveloptheskillsrequiredtousecommercialFEAsoftwarein2-Danalysis.
- Learn the basics of finite element analysis of trusses utilized to solve engineering problems.
- Solve the finite element analysis of beams.

Text Books:
1. Daryl L Logan, "A first course in the Finite element method", CCL Engineering publisher, 2012, 5th Edition, ISBN 13:978-0495668251
2. T. R. Chandrupatla and A. D. Belegundu, "Introduction to Finite Elements in Engineering",Pearson Publisher, 2011, 4th Edition, ISBN-13:978-0132162746.
3. 3. S.S. Rao, "Finite Elements Method in Engineering", Elsevier, 5th Edition, 2010,ISBN:978-1856176613.

Reference Books:
1. LakshminarayanaH.V, "Finite Elements Analysis - Procedures in Engineering", Universities Press(India)Pvt.Ltd.,2004,ISBN:9788173714764.
2. P.Seshu,"Text book of Finite Element Analysis", PHILearningPvt. limited, 2013, ISBN:978-8120323175.

E-resources:
1. http://nptel.ac.in/courses/112104116/
2. http://nptel.ac.in/courses/112106135/

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Computer Integrated Manufacturing

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET62	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to:
- Understand the basic concepts of computer integrated Manufacturing and HVPS.
- Study the devices used in automated assembly systems and AGVS.
- Know the concept of Flexible Manufacturing Systems and also to study how the inspection system is automated also application of computer in planning process.
- Impart working principle of computer numerical control machines and Automated Inspection and Testing.
- Students can able to write part programming for different lathe models and milling models.

Syllabus

Module – I

Computer Integrated Manufacturing System: Introduction, Automation definition, Typesofautomation,CIM,processinginmanufacturing,productionconcepts, Mathematical Models:- Manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, work-in-process, WIP ratio, TIP ratio, Simple numerical problems.

High Volume Production System: Introduction, Automated flow line symbols, Objectives, Work part transport-continuous, Intermittent, Synchronous, Transfer Mechanism:-Linear-Walking beam, roller chain drive, Rotary- Rack and pinion, Ratchet and Pawl, Geneva wheel. **08Hours**

Module – II

Automated Assembly Systems: Design for automated assembly systems, types of automated assembly systems, parts feeding devices- Elements of parts delivery system-hopper, part feeder, selectors, feedback, escapement and placement devices, analysis of multistation, assembly machine with numerical problems, analysis of single station assembly with numerical problems, Automated Guided Vehicle System: Introduction, Vehicle guidance and routing, system management**. 08Hours**

Module – III

Computerized Manufacturing Planning System: Introduction, computer aided process planning, Retrieval type of process planning, Generative type of process planning, material requirement planning, Fundamental concepts of MRP, Capacity planning.

Group Technology and Flexible Manufacturing Systems: Part families, Parts classification and coding, production flow analysis, machine cell design, Benefits of Group technology, FMS workstation, Material handling and storage system, computer control systems, planning the FMS. **08 Hours**

Module – IV

Computer Controls in NC:CNC components, Functions of CNC control in Machines Tools, G-codes and M-codes, Tool length compensation, cutter compensation, canned cycle for drilling, threading, turning, Direct Numerical Control (DNC): Configuration of DNC system, Functions of DNC, Communication between DNC computer and MCU, Advantages and disadvantages of CNC, Advantages of DNC.

Automated Inspection and Testing: Inspection and testing, Automated inspection principles and methods. **08 Hours**

Module – V

NC Part Programming: Introduction to CNC machining center and CNC turning center, part programming, Fundamental steps involved in development of part programming for milling and turning. CNC programming for different lathe models and milling models.

Digital Manufacturing: Introduction and application   **08 Hours**

Course Outcomes:

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

- Describe Automation and CIM and able to solve production related problems.
- Analyze automated assembly line and solve single station assembly related problems.
- Demonstrate the concept of Group Technology and working of coordinate measuring machine.
- Able to identify the different components or parts of CNC machine
- Write CNC programme and steps involved in development of part programming.

Text Books:

1. M.P.Groover, "Automation, Production system & Computer Integrated manufacturing", Prentice Hall India, publications, 2nd Edition,2007, ISBN- 978-81-317-0227-8.
2. S. Kant Vajpayee, "Principles of Computer Integrated Manufacturing", Prentice Hall India Publications, 1st edition, 2007, ISBN-978-81-203-1476-4.
3. CAD/CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.

Reference Books:

1. Mikell P. Groover and Emory W. Zimmers," Computer Aided Design and Computer Aided Manufacturing", Prentice Hall India, publications, 2nd Edition,2006, ISBN-978-81-203-0402-4.
2. P. Radhakrishnan, S. Subramanyam and V.Raju, "CAD/CAM/CIM", New Age International (P) Limited Publishers, 3rd Edition, 2008, ISBN-978-81-224-2236-5.
3. Principles of Computer Integrated Manufacturing, S.Kant Vajpayee, 1999, Prentice Hall of India, New Delhi.

E-resources:

1. http://nptel.ac.in/courses/112105211/
2. http://nptel.ac.in/courses/112103174/

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Heat and Mass Transfer

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET63	3:2:0:0	4	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to :
- Understand Modes and basic laws of heat transfer, one dimensional steady state conduction.
- Know the unsteady state conduction with lumped analysis and use of Heisler charts.
- Study convective heat transfer in free and forced convection from walls, cylinder etc.
- Learn heat exchangers with LMTD and NTU methods.
- Impart knowledge of radiation heat transfer for different cases including radiation shield.

Syllabus

Module – I

Introductory concepts: Modes of Heat Transfer, Basic Laws of Heat Transfer, Overall Heat Transfer Coefficient, Boundary Conditions, 3-D Conduction equation In Cartesian coordinates, Discussion On 3-D Conduction equation in Cylindrical and Spherical coordinate systems. 1-DConductionequationsinCartesian, Cylindrical and Spherical Coordinate Systems. Composite Walls, Cylinders and Spherical Systems with Constant Thermal Conductivity, Numerical. **10 Hours**

Module – II

One-Dimensional Transient Conduction: Conduction in solids with negligible internal temperature gradient (Lumped system analysis),Use of Transient temperature charts (Heisler's charts) for transient charts for transient conduction in semi-infinite solids. Numerical. **08Hours**

Module – III

Natural or Free convection: Application of dimensional analysis for free convection. Physical significance of Grassh off number, Rayleigh number. Use of correlations in free convection for horizontal, vertical plates and cylinders, Numerical.

Forced convection heat transfer: Application of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of correlations for hydro-dynamically and thermally developed flows in case of a flow through tubes, flow over a flat plate, cylinder and across a tube bundle. Numerical. **08Hours**

Module – IV

Heat exchangers: Classification of heat exchangers, Tubular and compact heat exchangers, overall heat transfer coefficient, fouling factor, L.M.T.D method, effectiveness, NTU method of analysis of heat exchangers, Numerical, Introduction to shell and tube, Plate type heat exchanger **08 Hours**

Module – V

Radiation Heat Transfer: Thermal radiation, definitions of various terms used in radiation heat transfer, Stefan-Boltzmanlaw, Kirchoff`slaw, Planck`s law and Wein`s displacement law, Radiation heat exchange between two parallel infinite black surfaces and gray surfaces, effect of radiation, Radiation shape factor, properties of shape factors, Numerical.

Introduction to Mass Transfer: Fick`s law of diffusion mass transfer, case studies, numerical. **08 Hours**

Course Outcomes:
Upon the completion of the course, the students will be able to:
- Describe the calculation of one-dimensional steady state conduction heat transfer through plane wall.

- Determine temperature and heat flow for unsteady state conduction.
- Students will understand the evaluation of convective heat transfer in free and forced convection.
- Identify the heat exchangers using LMTD and NTU methods.
- Describe the radiation heat transfer problems for different cases including radiation shield.

Data Hand Books

1. C.P.Kothandaraman& S Subramanyan "Heat and Mass Transfer", New Age Internationalpublisher.
2. R.Niranjanmurthy,"ThermodynamicDataHandBook",PublishedbySapnabookhouse,ISBN:9788128000041

Text Books:

1. S.C. Sachdev,"Heatand Mass Transfer", New Age International,4thEdition , 2010,ISBN:978-8122427851.
2. Ozisik," Basic Heat Transfer", McGraw-Hillpublications,1stEdition, 2011,ISBN:978-0070479807.
3. Rajputh, "Heat and mass transfer", 5th edition, 2009, sapana house

Reference Books:

1. YunusA Cenegal, "Heat Transfer, a practical approach", Tata McGraw-Hill publishers,2ndEdition, 2006,ISBN:978-0072458930.
2. J.P Holmon, "Heat Transfer", McGraw-Hill Publishers, Special Indian Edition, 2011,ISBN:978-0078447853.
3. 3. O.P. Khanna: "Heat Mass Transfer", Dhanpat Rai Publication, 2nd Edition, 2006, ISBN-13: 9789383182459.

E-resources:

1. http://nptel.ac.in/courses/112101097/

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Design of Transmission Elements

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET641	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to :

- Impart the knowledge of springs, fluctuating stress and its effects on springs.
- Realize the importance of gears, steps involved in design of spur gears and analyze different strength parameters in spur gear.
- Study the steps involved in design of helical & bevel gears and analyze different strength parameters in helical & bevel gears.
- Learn the need of lubrication and mechanisms and friction reduction in journal bearings.
- To know the criteria of how clutches and brakes are to be designed

Syllabus

Module – I

Springs: Types of springs, Functions and applications of springs, Spring materials, Surge in springs, end styles, Terminology of Helical Springs, Stresses in Helical coil springs o f circular cross-sections. Expression for strain energy stored in springs, design considerations, Belleville springs, springs under fluctuating loads, Leaf Springs: Stresses in leaf springs. Equalized stresses (Nipping), Rope drive and application in lift and concept of escalator design. AMT.   **09Hours**

Module – II

Spur gears: Introduction, Classification of Gears, advantages and disadvantages of gears over belt drives, Spur Gears: Terminology, Forces analysis, Beam strength of spur gear tooth. Lewis Equation and form factor, Design for strength, Dynamic Load and wear load, Numerical.   **08Hours**

Module – III

Helical Gears: Terminology, Forces analysis, formative/virtual number of teeth, Beam strength of helical gear tooth. Lewis Equation and form factor, Design for strength, Dynamic Load and wear load.

Bevel Gears: Terminology of Bevel Gears, Force Analysis, Beam strength, effective load on gear tooth, design procedure, Design as recommended by AGMA, Numerical.   **08 Hours**

Module – IV

Lubrication and Bearings: Types of wear, Types of lubricants and their properties, Selection of Lubricants, classification of bearings, Mechanisms of Lubrication in bearings, Bearing characteristic number and bearing modulus, sommer feld number,petroff'sEquation,coefficientoffriction,minimumoilfilmthickness,HeatGener ated, Heat dissipated, Bearing Materials, Examples of journal bearing.
09Hours

Module – V

Brakes and Clutches: Force and torque calculations and design procedure for Block brakes, Internally expanding brakes and Disc Types, friction materials & properties, Torque transmitting capacity- Uniform pressure & wear theory. Design of Single plate, multi plate and cone clutch.   **09Hours**

Course Outcomes:

Upon the completion of the course, the students will be able to:
- Make proper assumptions with respect to material, size, static and dynamic loads for springs.
- Design of spur gears for different power transmission ratio and to find BHN.
- Analyze helical & bevel gears based on strength dynamic and wear loads.
- Apply the knowledge to reduce friction using different lubrication

mechanisms and forces acting on bearings.
- Design and formulate torque transmitting capacity of clutch and brake for uniform pressure and wear condition

Design Data Hand Books
1. Design Data Hand Book – K. Lingaiah, McGraw Hill, 2nd Ed.2003.
2. Design Data Hand Book by K. Mahadevan and BalaveeraReddy, CBS Publication
3. Machine Design Data Hand Book by H.G.Patil, Shri Shashi Prakashan, Belgaum.

Text Books:
1. Joseph E Shigley and Charles R. Mischke. "Mechanical Engineering Design", Tata McGraw Hill Publishing Company Ltd., New Delhi, 8thEdition, 2008 ,ISBN-978-0-07-066861-4.
2. V.B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rdEdition, 2013, ISBN 978-0- 07-068179-8

Reference Books:
1. Robert L. Norton "Machine Design", Pearson Education Asia, 2ndedition 2000.ISBN-81-7808-434-1.
2. M.F.Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram and C.V. Venkatesh "Design of Machine Elements", Pearson Education, 8th Edition,2006,ISBN81-7758-421-9.
3. 3. Sharma, purohitc.s and kamalesh. "Design of Machine Elements", Pearson publications New Delhi, 2ndEdition, 2003,ISBN-81-203-1955-9

E-resources:
1. http://nptel.ac.in/courses/112106137/
2. http://nptel.ac.in/syllabus/112106138/

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Refrigeration and Air Conditioning

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19ME642	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to:
- Understand Methods of Refrigeration and Gas Cycle Refrigeration
- Develop skills in Refrigerants and its types and frictional, dynamic losses in air conditioning systems.
- Study the working principle of vapour compression refrigeration system.
- Impart the knowledge of vapour absorption refrigeration system and its components.

- Know basic concept of air conditioning design & its load calculations.

Syllabus

Module – I

Methods of Refrigeration: Ice refrigeration, evaporative refrigeration, air refrigeration, Vapour refrigeration, dry ice refrigeration, thermo electric refrigeration, pulse tube refrigeration, thermo acoustic refrigeration.

Gas Cycle Refrigeration: Introduction, reverse Carnot cycle, Bell Coleman Cycle, advantages &disadvantages of gas refrigeration system. Applications to aircraft refrigeration, Analysis of gas refrigeration and numericals.   **08Hours**

Module – II

Refrigerants: Types of Refrigerants, Comparative study of Ethane and Methane derivatives, selection of Refrigerants, Requirements of Refrigerants Effects of lubricants in Refrigerants, substitutes of CFC Refrigerants.

Transmission And Distribution Of Air: Room Air Distribution, Friction loss in ducts, dynamic losses in ducts, Air flow through simple Duct system, Duct design, Numerical   **08 Hours**

Module – III

Equipments Used In Vapour Compression Refrigeration System: Compressors: Principle, types of compressors, capacity control. Condensers: Types and construction, Expansion devices: Types- Automatic expansion valve, Thermostatic expansion valves, capillary tube. Sizing Evaporator: Types & construction, simple numerical   **08Hours**

Module – IV

Vapour Absorption System: Common refrigerant absorbent combinations, Binary mixtures, Ammonia Water Absorption system, Actual Vapour absorption cycle and its representation on enthalpy. Composition diagram, calculations. Triple fluid Vapour absorption refrigeration system. Water –Lithium Bromide absorption chiller, Numerical   **08 Hours**

Module – V

Design Conditions: Outside design conditions, choice of inside conditions, comfort chart. Choice of supply design condition.

Load Calculations and Applied Psychometrics: Internal heat gains, system heat gains, break up of ventilation load and effective sensible heat factor, Bypass factor, cooling load estimate. Psychometric calculations for cooling. Selection of Air

conditioning apparatus for cooling and dehumidification, evaporative cooling, numerical. **08Hours**

Course Outcomes:

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

- Describe the methods of Refrigeration and Gas cycles.
- AnalyzethedifferenttypesofrefrigerantsandTransmissionandDistribution of Air.
- Concept of Vapour Compression Refrigeration System.
- Expose knowledge of working of Vapour Absorption Refrigeration System.
- To Analyze the Design Conditions, Load Calculations and properties & process of Psychometrics.

Text Books:

1. C.P.Arora, "Refrigeration and Air-Conditioning", Tata McGraw Hill Publication, 2^{nd}Edition,2001, ISBN-13:978-0-07-463010-5.
2. Dossat,"PrinciplesofRefrigeration",Pearson Publication, 4^{th}Edition, 2006, ISBN:978-81-7758-881-1.

Reference Books:

1. Shan K Wang, ZalmanLawan, Paul Norton, "Air conditioning and Refrigeration Engineering", CRC Press, 2^{nd}Edition,

   ISBN: 0-8493-0057-6.
2. Stephen M. Elonka, Quaid W. Minich, "Standard Refrigeration and Air-Conditioning",TataMcGrawHillPublication,2^{nd}Edition, 1982,ISBN:0970992835.

E-resources:

1. http://nptel.ac.in/courses/112105128/
2. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Ref%20and%20Air%20Cond/New_index1.html

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Lab View For Industrial Automation

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET643	3:0:0:0	3	CIE:50 SEE:50	3	PEC

Course Objectives:

This course will enable students to :

- Understand the fundamental of graphical coding system.
- Learn to develop basic level of Lab VIEW coding.
- Study the different component of Lab VIEW operating tools.
- Study and develop state machine for a specific problem.
- Develop integrated coding solution for analysis and presentation with My Rio hardware using accelerometer.

Syllabus

Module – I

Lab VIEW programming concepts, environment and Software constructs: Data flow, Polymorphism, Front panel window, block diagram, and connector pane, Menus and palettes, Configuration options. Controls, indicators, IO controls, and refunds Terminals, constants, nodes, update modes, and legends of charts and graphs. Mechanical action of Boolean objects Property Nodes. Numeric, string, Boolean, and path data types. Array and cluster data types. Shift registers, Case, Sequence and Event structures. **10 Hours**

Module – II

Programming, Data communication and synchronization VIs and functions: Conversion, comparison, and manipulation, Timing and Timing functions related to Timed structures. Data storage and file I/O formats, Waveform and waveform file I/O, Dynamic and User events Local, global, and shared variables Data Socket TCP and UDP Notifies Queues Semaphores Property Nodes, and Invoke Nodes.

08 Hours

Module – III

Error handling VIs and functions: Error clusters Dialog and User Interface VIs Custom error codes. Design patterns: Simple state machine, User interface event handler, Queued message handler, producer/consumer (data) and producer/consumer (events), Functional global variables. **06 Hours**

Module – IV

Sub VI design: Sub VI creation methods, Connector panes and connection types, Polymorphic sub VIs, Options related.

Debugging tools and techniques: Debugging tools, Error list window, Execution highlighting, Breakpoints and single stepping, Generic and custom probes, Debugging practices and techniques for different situations. **08 Hours**

Module – V

VI design and documentation (style) practices: Refer to the Lab VIEW Style Checklist topic of the Lab VIEW Help for information on the following items

i. User interface design and block diagram layout

ii. Modular and hierarchical design

iii. Sub VI icons and connector pane layout (standard)

iv. Properties

v. Documenting Vis Memory, performance, and determination

a. Tools for identifying memory and performance issues

Profile memory and performance, Show buffer allocations and VI metrics

b. Programming practices Enforcing dataflow, User interface updates and response to user interface controls, Data type selection, coercion, and buffer allocation, Array, string, and loop operations **08 Hours**

Course Outcomes:

Completion of this course, students will be able to :

- Formulate basic aspects of the graphical programming using Lab VIEW 2016.
- Develop Lab VIEW coding for a specific problem of data logging, measurement and presentation.
- Handle the error function and errors in the Lab VIEW coding.
- Develop coding for data handling and Analysis on the acquired data.
- Design a state machine Lab VIEW coding for an applied problem.

Text Books:

1. NI, "Lab VIEW - Getting Started with Lab VIEW", M/s National Instruments, 2013373427J-01.

2. Jovitha Jerome: "Virtual instrumentation using lab view", PHI Learning Pvt. Ltd.,2010.

3. Hans-Petter Halvorsen: "Introduction to Lab VIEW," University College ofSoutheast, Norway.

4. S. Sumathi, P. Surekha, "LabVIEW based Advanced Instrumentation Systems",Springer.

5. Laboratory manual provided by Dept. of Mechanical Engineering, NCET.

Reference Books:

1. Jeffrey Travis, Jim Kring: "Introduction to Graphical Programming with LabVIEW",Pearson, 2006.

2. Malan Shiralkar: "LabVIEW Graphical Programming Course Collection", National Instruments.

E-resources:

1. http://cnx.org/content/col10241/1.4.

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Non-Destructive Testing of Materials

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET651	3:0:0:0	3	CIE:50 SEE:50	3 Hours	MEP

Course Objectives:

This course will enable students to:
- Understand the objectives and uses of NDT methods with various types of discontinuities.
- Describe how liquid penetrant test can be used to detect surface discontinuities and also methods used in MPT.
- Evaluate ultrasonic testing and acoustic emission testing.
- Describe the stages of development of x-ray film in radiographic testing.
- Understand and appreciated how eddy current data is evaluated and interpreted.

Syllabus

Module – I

Overview Of NDT And Visual Inspection Method:-Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, various physical characteristics of materials and their applications in NDT, Visual inspection – Unaided and aided. Visual testing using various gauges, direct, indirect method, measurement, calibration, interpretation, reporting.   **08 Hours**

Module – II

Surface NDE Methods (LPT & MT):-Liquid Penetrant Testing - Principles, types and properties of liquid penetrant, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials, Interpretation and evaluation of test indications, Principles and methods of demagnetization.   **07 Hours**

Module – III

Ultrasonic Testing (UT) & Acoustic Emission Testing (AET):-Introduction, Principle of operation, Terminologies used in UT, UT methods, Types of Transducers, ultrasonic testing techniques. Method for evaluating Discontinuities-ultrasonic testing procedures for different component, data representation-A scan, B scan & C scan, applications, advantages and limitations.

Acoustic Emission testing- principle and parameters in AET.   **08 Hours**

Module – IV

Radiography Testing (RT):- Principle, Procedure for RT, Gamma ray RT, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square law, characteristics of films – graininess, density, speed, characteristic curves, Image quality- Penetro meters, Exposure charts, Radiographic techniques- Single wall single image, Double wall single image, double wall double image techniques, Fluoroscopy, Xero-Radiography.   (Safety standards and measurement)   **09 Hours**

Eddy Current Testing (ET):-Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, working principle, Eddy current sensing elements, Probes, Instrumentation, Parameters of ECT, Applications, advantages, Limitations, Interpretation/Evaluation, Practical applications of ECT.   **08 Hours**

Course Outcomes:
On completion of this course, the students are able to:
- Use the various NDT methods for defects and characterization of industrial components.
- Identify the leak test by using various types of penetrant and developers using LPT and MPT.
- Evaluate the discontinuities by using UT techniques.
- Interpret the imaging films by using x-ray radiography techniques.
- Evaluate the results by the generation of eddy currents.

Text Books:
1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", NarosaPublishing House, 2009.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New AgeInternational Publishers, 2010.
3. Dr. v Jyakumar& Dr. KElangovan , "Nondestructive testing of materials", Lakshmi publications, first edition, 2017.

Reference Books:
1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Volume-17, Metals Park, Ohio, USA, 2000.
2. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition, New Jersey, 2005.
3. Charles, J. Hellier," Handbook of Non-destructive evaluation", McGraw Hill, New York 2001.
4. ASNT, American Society for Non-Destructive Testing, Columbus, Ohio.
5. NDT Handbook,Vol. 1,Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 4,Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol.7, Ultrasonic Testing.

E-Resources:
1. https://nptel.ac.in/courses/113/106/113106070/
2. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mm07/
3. https://freevideolectures.com/course/4835/nptel-theory-practice-non-destructive-testing

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Operations Research

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET652	3:0:0:0	3	CIE:50 SEE:50	3 Hours	MEP

Course Objectives:

This course will enable students to:

- Understand the fundamentals of OR, formulation of linear programming problems.
- Study the basic knowledge in various types of transportation and assignment problems.
- Impart the fundamental concepts related to PERT-CPM techniques.
- Learn the Game theory, solution by graphical method and dominance rule and various types of sequencing methods
- Problems solving using software.

Syllabus

Module – I

Introduction: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, Formulation of LPP, Graphical solutions. Linear programming (LP) problems-The Simplex Method, Big M method, Numerical. **08 Hours**

Module – II

Transportation problem: Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases, Numerical **08 Hours**

Module – III

Pert-CPM Techniques: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project, Numerical **08 Hours**

Module – IV

Game theory: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games.

Queing theory: Queing systems and their characteristics, M/M/1 Queing systems, problems. **08 Hours**

Module – V

Sequencing: Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines,'n' jobs on 'm' machines, Sequencing 2 jobs on 'm' machines using graphical method. **08 Hours**

Discussion on the following

1. Introduction to micro soft XL solver ADD-IN software.
2. Linear programming problems analytical method.
3. Linear programming problems using graphical method.
4. Transportation Problem.
5. Assignment Problem.
6. Ghaet Chart drawing.
7. Pert-CPM Techniques.
8. Simple problems on Game theory.
9. Formulation of Queing theory problems.

Course Outcomes:

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

- Describe the fundamental concepts of OR and formulate the linear programming problems.
- Solve various types of problems related to Transportation and Assignment.
- Construct the network find the expected duration and probability of completing a project.
- Formulate the games and find the solution for various types of games and various types of sequencing problems
- Solve various types of problems using software.

Text Books:

1. P K Gupta and D S Hira, "Operations Research", Chand Publications, 5th Edition, 2011, ISBN:81-219-0281-9.
2. Taha H A, "Operations Research", Pearson Education, 7thEdition, 2004, ISBN:81-203-2235-5
3. Niranjan Murthy, "Operation Research", 9th edition, sapana house.

Reference Books:

1. Paneerselvam, "Operations Research", PHI Publications, 2nd Edition, 2011**,** ISBN:978-81-203-2928-7
2. A M Natarajan, P Balasubramani, "Operations Research", Pearson Education, 3rd Edition, 2009, ISBN:978-81-317-0000-6
3. S.D. Sharma, "Operations Research", Kedarnath Ramnath Publications, 17th Edition, 2014, ISBN:93-80803-389

E-resources:
1. http://nptel.ac.in/courses/112106134/1

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Industrial Internet of Things (IOT)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET653	3:0:0:0	3	CIE:50 SEE:50	3 hours	MEP

Course Objectives:

This course will enable students to

- Assess the genesis and impact of IoT applications.
- Illustrate diverse methods of deploying smart objects and connect them to network.
- Compare different Application protocols for IoT.
- Infer the role of Data Analytics and Security in IoT.
- Identify sensor technologies for sensing real world entities and understand the role of IoT in various domains of Industry.

Syllabus

Module – 1

IoT:-Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack. **08 Hours**

Module – 2

Smart Objects: Sensors, Actuators and Smart Objects, Sensor Networks, Connecting Smart Objects, Power networks, Signal communication, Communication protocol, IoT Access Technologies and Internet launch. **07 Hours**

Module – 3

Protocols for IoT: IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods. **07 Hours**

Module – 4

Data and Analytics for IoT: An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures. **08 Hours**

Module – 5

IoT Physical Devices and End Pints: Arduino UNO, Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints.

Raspberry Pi: Introduction to Raspberry Pi, About the Raspberry Pi Board, Hardware Layout, Operating Systems on Raspberry Pi, Configuring Raspberry Pi, Programming Raspberry Pi with Python, Report generation and alarming (Case studies)   **09 Hours**

Course Outcomes:

After studying this course, students will be able to

- Interpret the impact and challenges posed by IoT networks
- Compare and contrast the deployment of smart objects and the technologies
- Appraise the role of IoT protocols for efficient networkcommunication.
- Describe the need for Data Analytics and Security in IoT.
- Illustrate different sensor technologies and identify the applications of IoT in Industry.

Text Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1stEdition, Pearson Education (Cisco Press Indian Reprint). ISBN: 978- 9386873743.
2. Srinivasa K G,Siddesh G. M., HanumanthaRaju R.,"Internet of Things",CENGAGE Leaning India, ISBN-13: 978-9386858955.
3. Olivier Hersent, David Boswarthick, Omar Elloumi,"The Internet of Things: Key Applications and Protocols", Wiley, ISBN-13: 978-8126557653.

Reference Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (AHands-on-Approach)",
   1stEdition, VPT, 2014. (ISBN: 978-8173719547)
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN:978-9352605224)
3. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress; 1st Edition, ISBN-13: 978-1484220467.

E-Resources :

1. https://nptel.ac.in/courses/106/105/106105195/
2. https://nptel.ac.in/courses/106/105/106105166/

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Hydraulics and Pneumatics

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET661	3:0:0:0	3	CIE:50 SEE:50	3 hours	MEP

Course Objectives:

This course will enable students to :

- Know about the working of hydraulic and pneumatic systems.
- Understand the energy transfer in hydraulic actuators and motors
- Know about controlling components of hydraulic and pneumatic systems.
- Familiarize the hydraulic and pneumatic systems and analyze them.
- Introduce the concept of signal processing elements and control.

Syllabus

Module – I

Introduction to Hydraulic Power: Pascal's law and problems on Pascal's Law, continuity equations, introduction to conversion of units, Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps.

Hydraulic Actuators: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading. **07Hours**

Module – II

Hydraulic Motors: Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.

Control Components in Hydraulic Systems: Directional Control Valves – Symbolic representation, Constructional features, pressure control valves – direct and pilot operated types, flow control valves. **09Hour**

Module – III

Hydraulic Circuit Design and Analysis: Control of single and double–acting hydraulic cylinder, regenerative circuit, pump unloading circuit, counter balance valve application, hydraulic cylinder sequencing circuits. Cylinder synchronizing circuits, speed control of hydraulic cylinder ,speed control of hydraulic motors, Accumulators.

MaintenanceofHydraulicSystems: Hydraulicoils;desirableproperties,generaltype of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination,

temperature control, trouble shooting. 08Hours

Module – IV

Introduction to Pneumatic Control: Choice of working medium, characteristics of compressed air. Structure of pneumatic control system. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, filters, regulators, lubricators, distribution of compressed air.

Pneumatic Actuators: Linear cylinders–types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications.

08Hours

Module – V

Directional Control Valves: Symbolic representation as per ISO 1219 and ISO 5599. Designandconstructionalaspects,poppetvalves,slidevalvesspoolvalve,suspended seat type slide valve. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve. Flow control valves and speed control of cylinderssupplyairthrottlingandexhaustairthrottling,useofquickexhaustvalve.

Signal Processing Elements: Use of Logic gates – OR and AND gates pneumatic applications,practicalexamplesinvolvingtheuseoflogicgates,Pressuredependent controls types construction– practical applications, time dependent controls – principle, construction,practicalapplications.**08Hours**

Course Outcomes:
 Upon the completion of the course, the student should be able to:
- Describe the working of hydraulic and pneumatic systems.
- Become aware about controlling components of hydraulic and pneumatic systems.
- Select, prepare and distribution of compressed air.
- Compile the design of hydraulic and pneumatic systems.
- Demonstrate the need of pressure and time dependent controls.

Text Books:
1. Anthony Esposito, "Fluid Power with applications", Pearson Education, 5thEdition,2010,ISBN:13-8456425689034.
2. Andrew Parr, "Pneumatics and Hydraulics", Jaico Publishing Co, 2011, 1stEdition,ISBN-13:8975356789053.
3. Dr. Mujumdar, "H and P", 3rd edition, 2006, Sapana book house.

Reference Books:
1. Niranjan Murthy and R.K.Hegde, "Hydraulics andPneumatics", Sapna publications, 2013,ISBN:13-8765213426009.

2. S.R. Majumdar, "Pneumatic Systems", Tata McGraw Hill publishing, 1stEdition, 1995,ISBN:9780071359658.
3. Niranjan, "Hydraulics and Pneumatics", 1st edition, 2005, Sapana book house.

E-resources:

1. http://nptel.ac.in/courses/112105046/

2. http://nptel.ac.in/courses/112103174/21

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Design of Jigs and Fixtures

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET662	3:0:0:0	3	CIE:50 SEE:50	3 Hours	MEP

Course Objectives:

This course will enable students to:

- Understand the fundamentals of tool design.
- Learn the design principles of Jigs, fixtures and press tools.
- Study various press working operations for mass production of sheet metal parts.
- Gain proficiency in the development of required views of the final design.
- Know the various metal forming processes used in manufacturing.

Syllabus

Module – I

Tool Design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

08 Hours

Module – II

Design And Development Of Jigs And Fixtures:- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fix turing systems- Quick change fixtures   **08 Hours**

Module – III

Press Working:- operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.   **08 Hours**

Module – IV

Bending And Drawing– Blank development, Types of Bending dies, Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.   **08 Hours**

Module – V

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies.

08 Hours

Course Outcomes:
Upon completion of this course, the students will able to
- Explain the fundamentals of tool design.

- Design jigs, fixtures and press tools.

- Demonstrate various press working operations for mass production of sheet metal parts

- Identify and select locating and clamping points on work-piece
- Describe the various metal forming processes used in manufacturing industries.

Text Books:
1. Joshi, P.H. "Jigs and Fixtures", Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2. Joshi P.H "Press tools – Design and Construction", wheels publishing, 1996
3. Venkataraman. K., "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi.

Reference Books:
1. Donaldson, Lecain and Goold "Tool Design", 3rd Edition, Tata McGraw Hill, 2000.
2. Kempster, "Jigs and Fixture Design", Third Edition, Hoddes and Stoughton, 1974.
3. Design Data Hand Book, PSG College of Technology, Coimbatore.

E-Resources:
1. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-33.pdf

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Software Testing

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET663	3:0:0:0	3	CIE:50 SEE:50	3 Hours	MEP

Syllabus

Module – I

Introduction:-Testing as an Engineering Activity, Role of Process in Software Quality, Testing as a Process, Basic Definitions, Software Testing Principles, The Tester's Role in a Software Development Organization, Origins of Defects, Defect Classes, The Defect, Repository and Test Design, Defect Examples, Developer/Tester Support for Developing a Defect Repository. **08 Hours**

Module – II

Test Case Design:- Introduction to Testing Design Strategies, The Smarter Tester, Test Case Design Strategies, Using Black Box Approach to Test Case Design Random Testing, Requirements based testing, positive and negative testing, Boundary Value Analysis, decision tables, Equivalence Class Partitioning state-based testing, cause effect graphing, error guessing, compatibility testing, user documentation testing, domain testing Using White, Box Approach to Test design, Test Adequacy Criteria, static testing vs. structural testing, code functional testing, Coverage and Control Flow Graphs, Covering Code Logic Paths, Their Role in White, box Based Test Design, code complexity testing, Evaluating Test Adequacy Criteria. **08 Hours**

Module – III

Levels of Testing:- The Need for Levels of Testing, Unit Test, Unit Test Planning, Designing the Unit Tests. The Test Harness, Running the Unit tests and Recording result, Integration tests, Designing Integration Tests, Integration Test Planning, scenario testing, defect bash elimination, System Testing, types of system testing, Acceptance testing, performance testing Regression Testing, internationalization testing, ad hoc testing, Alpha Beta Tests, testing OO systems, usability and accessibility testing. **08 Hours**

Module – IV

Test Management:- People and organizational issues in testing, organization structures for testing teams, testing services, Test Planning, Test Plan Components, Test Plan Attachments, Locating Test Items, test management, test process, Reporting Test Results, The role of three groups in Test Planning and Policy Development, Introducing the test specialist, Skills needed by a test specialist, Building a Testing Group. **08 Hours**

Controlling and Monitoring:- Software test automation, skills needed for automation, scope of automation, design and architecture for automation, requirements for a test tool, challenges in automation, Test metrics and measurements, project, progress and productivity metrics, Status Meetings, Reports and Control Issues, Criteria for Test Completion, SCM, Types of reviews, Developing a review program, Components of Review Plans, Reporting Review Results, evaluating software quality, defect prevention, testing maturity model   **08 Hours**

Text Books:

1. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson education, 2006

2. Aditya P.Mathur, "Foundations of Software Testing", Pearson Education, 2008. 87

Reference Books:

1. Boris Beizer, "Software Testing Techniques", Second Edition, Dreamtech, 200
2. Elfriede Dustin, "Effective Software Testing", First Edition, Pearson Education, 2003
3. Renu Rajani, Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill, 2004.

E-resources:

1. http://www.annaunivedu.in/2012/08/it2032-software-testing-syllabus-anna.html#ixzz6TPk2SkjE

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Computer Integrated Manufacturing & Automation Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEL67	2:0:0:0	2	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to :

- Demonstrate the concepts discussed in Computer Integrated Manufacturing course.
- Introduce CNC part programming for simulation of various machining operations.
- Educate the students on the simulation of CNC programming for the various types of models.

Syllabus

PART-A

CNC part programming using CAM packages such as Box turning & Face turning and Simulation of Turning, operations.

Typical simulation to be carried out using simulation packages Like DENFORD software

PART-B

CNC part programming using CAM packages such as Milling and drilling operations and Simulation of Milling & Drilling operations.
4 Typical simulations to be carried out using simulation packages Like DENFORD software.

Course Outcomes:

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

- Practically relate to concepts discussed in Computer Integrated Manufacturing course.
- Write CNC part programs using DENFORD simulation package for simulation of machining operations such as Turning, Drilling & Milling.
- Understand & write programs for Flexible Manufacturing Systems.
- Apply these learnings to automate & improve efficiency of manufacturing process.

Scheme of Examination:

One question is to be set from Part-A: 20 Marks

One question is to be set from Part-B : 20 Marks

Viva-Voce : 10 Marks

Total: 50 Marks

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Heat and Mass Transfer Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEL68	2:0:0:0	2	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to :

- Understand the modes of heat transfer.
- Know the laws of heat transfer.
- Study the applications of fins and heat exchangers in automobiles and industries.
- Determine the performance of refrigeration and air conditioner.

Syllabus

PART-A

1. Determination of Thermal Conductivity of a Metal Rod.
2. Determination of Effectiveness on a Metallic fin.
3. Determination of Heat Transfer Coefficient in a free Convection on a vertical tube.
4. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
5. Determination of Emissivity of a Surface.

PART-B

1. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
2. Experiments on Shell and tube heat exchanger.
3. Performance Test on a Vapour Compression Refrigeration system.
4. Performance Test on a Vapour Compression Air –Conditioning system.
5. Experiment on Transient Conduction Heat Transfer.

Course Outcomes:

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

- To understand the skills in the experimental measurement of heat & mass transfer processes.
- To know & solve the problems on modes of heat transfer.
- Design vapor compression refrigerator & air conditioner based on interpretation of experimental data.

Scheme for Examination:

One Question from Part A : 15 Marks (05 Write up +15)

One Question from Part B :25 Marks (05 Write up +15)

<u>Viva-Voce : 10 Marks</u>

Total : 50 Marks

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Mechanical Vibrations and Noise

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEI71	2:2:0:0	3	CIE:50 SEE:50	3 Hours	PCC

Course Objectives:

This course will enable students to :

- Impart knowledge on the fundamentals of mechanical vibrations and Noise Pollution.
- Study the free vibrations under damped and undamped cases.
- Learn about the force vibrations and various vibration measuring instruments.
- Study the modal analysis, condition monitoring methods and analyze mathematical model of two degree freedom system.
- Finding out the natural frequencies using various numerical methods for multi degree of freedom systems.

Syllabus

Module – I

Fundamentals of Vibrations: Concept of Vibration, Definitions, Type of vibrations, Simple Harmonic Motion (SHM), Principle of super position applied to SHM, numerical problems.

Noise Pollution: Basics of acoustics and specification of sound, sound power, sound intensity and sound pressure levels, Types of Noise, plane, point and line sources, multiple sources, outdoor and indoor noise propagation, psycho-acoustics, noise evaluation indices and basis for criteria   **10Hours**

Module – II

Undamped Free Vibrations of Single DOF systems: Introduction, Derivation of differential equations, Natural frequency of simple systems, Springs in series and parallel combinations, Effect of mass of spring, Torsional vibrations, numerical problems.

Damped Free Vibrations of Single DOF systems: Types of damping, viscous damping. Derivations for over, critical and under damped systems, Logarithmic decrement, numerical problems.   **10 Hours**

Module – III

Forced Vibrations of Single DOF systems: Introduction, forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, Force and motion transmissibility, numerical problems.

Vibration Measuring Instruments and Critical Speeds of Shafts: Introduction, Vibration measuring scheme, Vibrometers, Accelerometer, Frequency measuring instruments, Whirling of shafts with and without damping, numerical problems on critical speed of shaft.   **10 Hours**

<div align="center">**Module – IV**</div>

Modal analysis and Condition Monitoring: Signal analysis, dynamic testing of machines and structures, Experimental modal analysis, Machine condition monitoring and diagnosis

Systems with two degrees of Freedom: Introduction, Principle modes of vibrations, Normal mode and natural frequencies of systems, Torsional systems, static & dynamic coupling, numerical problems. **10 Hours**

<div align="center">**Module – V**</div>

Numerical Methods for multi degree freedom of systems: Introduction, Maxwell's reciprocal theorem, Influence coefficients, Rayleigh's method, Dunkerley's method, Stodola method, Holzer's method, numerical Problems. **12 Hours**

Course Outcomes: .
On completion of this course, the students will be able to:
- Gain knowledge on the fundamentals of mechanical vibrations and methods to reduce noise pollution.
- Develop skills to deploy the different damping systems under free vibrations.
- Utilize the concept of forced vibrations and know about various vibration measuring instruments.
- Monitor and analyze the vibration signals and idealize any physical system into two DOF systems.
- Solve multi DOF system and obtain their natural frequencies, which help the engineer to design stable systems.

Text Books:
1. S. S. Rao, "Mechanical Vibrations", Pearson Education Inc, 5th edition, ISBN-13: 978-0132128193.
2. V. P. Singh, "Mechanical Vibrations",BDhanpatRai Publications, 4th Edition,2014, ISBN:978-8157004014.

Reference Books:
1. G. K. Grover, "Mechanical Vibrations", Nem Chand and Bros, 8th edition, 2009, ISBN-13: 978-8185240565.

2. 2. J. S. Rao & K. Gupta, "Theory and Practice of Mechanical Vibrations", New Age International Publications, New Delhi, 2nd Edition reprint, 2014, ISBN 978-81-224-1215-4

E-resources:
1. http://nptel.ac.in/courses/112103111/
2. https://ocw.mit.edu/courses/mechanical-engineering

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Small and Medium Enterprise Management

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET721	2:0:2:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to :
- Know the various concepts of Entrepreneurship and familiarize them with the contemporary environment of MSMEs.
- Familiarize the Business Environment required for MSMEs.
- Elucidate the Process of Enterprise Creation.
- Understand the creation of Business Plan and Institutional Support Mechanism.
- Recognize the concepts of marketing management in the MSMEs.

Syllabus

Module – I

Basic Aspects: Concept, nature of Entrepreneur and Entrepreneurship, Distinction between Entrepreneur and Manager, Entrepreneurship, Medium, Small and Tiny Business: Definition, Role in the economy and significance, Changing scenario of MSMEs in the era of Liberalization and Globalization, Competitiveness.   **08 Hours**

Module – II

Environment Assessment: Political, Legal, Economic, Social, Technological, Global environment, Assessment of business opportunities, Government initiatives and private sector opportunity. Industrial Safety and Policies.   **08 Hours**

Module – III

Enterprise Creation: Starting a small industry, Entrepreneurial function or process of starting a new venture based on personal competencies, requirements to start a business venture, Feasibility of the project, Business incubators. Introduction to supply chain, (Case studies on DPR)   **08 Hours**

Module – IV

Business Plan: Developing effective business plan-meaning, benefits of business plan, Timing of the business plan, Length of the business plan, composition of the business plan or detailed project report. Institutional Support Mechanism: District Industries Centre, State Directorate of Industries, SIDBI, NSIC, SISI, KSFC, KIADB, TECSOK.   **08 Hours**

Module – V

Small Business Marketing: Concept of Marketing, Scope of Marketing, Marketing Mix, Product Mix, Channels of Distribution, Market Segmentation, Role of

Middlemen, Distribution Strategies, Sales Promotion, Advertising and Publicity, Packaging Strategies, Branding Strategies.   **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Visualize the various concepts of Entrepreneurship
- Demonstrate the knowledge of Business Environment with respect to MSMEs.
- Discuss the steps involved in Enterprise Creation.
- Prepare Business Plan and Understand the Institutional Support Mechanism.
- Know the marketing management with reference to MSMEs.

Text Books:
1. Shukla.M.B, "Entrepreneurship and Small Business Management", Kitab Mahal, Allahabad, 2011, ISBN-13: 978-8122502947.
2. Sahay A., V.Sharma, "Entrepreneurship and New Venture Creation", Excel Books, New Delhi, 2008. ISBN : ISBN-13: 978-8174466075.
3. P C Tripathy and P N Reddy , Principles of Management, Tata McGraw Hill, ISBN : 0070600589.

Reference Books:
1. S.Anil Kumar, "Small Business and Entrepreneurship", I.K .International Publishing House Pvt. Ltd., 2008. ISBN: :9788190694230.
2. Kotler, Keller, Koshy, Jha: "Marketing Management", 13th Edition, Pearson Education.
   ISBN : ISBN-10: 8131767167.
3. Lall, Sahai: "Entrepreneurship", Excel Books, New Delhi, ISBN-13: 978-8174466136.

E-Resources:
1. https://nptel.ac.in/courses/127/105/127105007/
2. https://www.kaushalkar.com/
3. https://www.startupindia.gov.in/

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Accountancy and Taxation

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET722	2:0:2:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to :

- Familiarize the students with the significance of taxation system.
- Understand the structure of Indian Taxation system.
- Gain knowledge about the practical aspects of Indian taxation.
- Understand the system of computation of tax from Salaries.
- Sketch the recent trends in Indian taxation system.

Syllabus

Module – I

Introduction to taxation system, Objectives of taxation, Factors to be considered for tax planning Canons of taxation, Types of taxation, Direct tax, Indirect tax (Broad perspective only). **07 Hours**

Module – II

Taxation system in India, Types o tax eslevied in India, Various heads of income tax (Broad outline only) Basic concepts in taxation, Assessment year, Financial year, assessee, Residential status, Tax liability **08 Hours**

Module – III

Income tax authorities in India, Constitution, Powers, Functions specimen of Form, 16,Filing of returns, tax evasion, Penalties for contravening the provisions of income tax. **08 Hours**

Module – IV

System of computation of tax from salaries, Taxable income, Permissible deductions from 80Cto80U Fringe benefits exempted from tax, exempted income under section 10 of Income tax act. **10 Hours**

Module – V

Trends in Indian taxation system, Self-assessment, PAN card, Budgetary provisions of the financial year2017-18ontaxation, GST, Advantages, Problems in implementing GST, Measures to overcome the limitations of GST. **06 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Gain knowledge about the system of taxation prevailing in the country.
- Compute tax under different heads.

- Gain practical knowledge on filing returns.
- Calculate the payable tax for salaried individuals.
- Gain insight into recent practices on taxation

Reference Books:

1. Dr. Vinod K. Singhania: "Direct taxes-Law and Practice",Taxmann Publication.
2. Dr. Mehrotra, Dr. Goyal: "Direct taxes- Law and Practice", SahityaBhavan Publication, 7 lectures-Income tax-I ", VBH.

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Assessment of Building Energy Performance

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET723	2:0:2:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to:

- Provide a foundation for performing a building energy audit
- Perform assessment tasks on building energy performance
- Submit a Building EQ rating
- Understand the methods and processes to be performed in the field
- Know the process of certifying professionals in energy assessment

Syllabus

Module – I

Introduction:- global energy consumption characteristics and the role of commercial and residential buildings, building energy end use consumption characteristics, impact of time variations in building energy consumption, Building mechanical, electrical, and lighting systems.   **08Hours**

Module – II

Anatomy of typical HVAC systems in commercial buildings , typical primary and secondary HVAC equipment and their role in meeting system requirements , basics of electrical distribution systems and their equipment in commercial buildings , basics of lighting system in buildings, including performance terminology, lighting technologies, energy performance, and the role of day lighting.   **08Hours**

Module – III

Introductiontobuildingenergybenchmarkingandassessment,differencesbetween benchmarking, labeling programs, and energy and environmental auditing, role of buildingtypeandclimatezoneonenergyuse,keyaspectsofENERGYSTAR®Portfolio Manager and other tools for benchmarking, ASHRAE Building EQ As Designed and In Operation ratings , differences between Building EQ and Portfolio Manager , Preliminary Energy Use Analysis (PEA)   **08Hours**

Module – IV

Measuring and monitoring building performance , instrumentation for measuring indoor environmental quality and building energy flows, Perform measurements of

indoor environmental quality and building energy flows , accuracy of building measurements, Identify the components of an ASHRAE Level 1 walk through survey and the differences between Level 1, 2, and 3 surveys , Indoor Environment Quality.
08 Hours

Module – V

Energy Efficiency Measures – Building Envelope and Lighting, role of building envelope characteristics on energy use, energy conservation and energy efficiency measures related to envelope and lighting characteristics, Energy Efficiency Measures – HVAC Systems, energy conservation and energy efficiency measures related to HVAC systems, financial analysis of expected improvements to HVAC systems.

08Hours

Course Outcomes:

On completion of the course, the student will be able to:
- ProduceanASHRAEBuildingEQInOperationratingforthebuildingsprovided   in the class
- Produce a listing of potential Energy Efficiency Measures (EEM) including financial pay back analysis
- Perform measurements of indoor environmental quality and HVAC system performance
- Identify different building types and determine the impact of climate on energy use.
- Analyse raw energy consumption data from measured-meter readings

Text Books:
1. ASHRAE Building Energy Quotient Program website
2. ASHRAE BEAP certification study guide
3. ASHRAE Standard 105-2014 Standard Methods of Determining, Expressing, and Comparing Building Energy Performance and Greenhouse Gas Emission

Reference Books:
1. ASHRAE Performance Measurement Protocols for Commercial Buildings: Best Practices Guide
2. ENERGY STAR® Portfolio Manager website

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Finite Element Analysis by Using Hypermesh

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET731	3:0:0:0	3	CIE:50 SEE:50	3 hours	PEC

Course Objectives:

This course will enable students to:

- Use Hypermesh and different boundary conditions.
- Use geometry editing tools for preparing CAD and CAE models used in the meshing process.
- Represent and use 1D elements.
- Represent and use 2D elements.
- Represent and use 3D elements.

Syllabus

Module – I

Introduction to Hyper Mesh: Getting started with Hypermesh, Analysis Types, Introduction to Finite Element Analysis, Working with Fe-Models. Model viewing option using permanent menu, understanding concept of Modeling/Pre-Processing, Solution, Post-Processing.

Introduction to Boundary conditions: Applying Boundary conditions creating systems, Applying load, Constrains. **06Hours**

Module – II

Working with Geometry: Geometry in Hyper Mesh, Hyper Mesh Geometry Terminology, Geometry Cleanup, Geometry Creation and Editing, Importing CAD Geometry, Basic operations \ failures. **08 Hours**

Module – III

1D Representation: When to Use 1D Elements, Special Features of Beam/Bar Elements, Rigid Elements, Fasteners, 1D Element Creation, Connectors in Hyper Mesh

06 Hours

Module – IV

2D Representation: Meshing with Hyper Mesh: When to Use 2D Elements, Family Of 2D Elements, Thin Shell Elements, Effect of Biasing in The Critical Region, Symmetric Boundary Conditions, Geometry Associative Mesh, How Not to Mesh, creating 2D Elements in Hyper Mesh, Auto meshing, Shrink Wrap Meshing**. 08Hours**

Module – V

3D Mesh Representation: When to Use 3D Elements ,3D Element Types, Dofs For Solid Elements, Tetra Meshing Techniques, Brick Meshing, Tips for Brick Meshing, How Not to Mesh, Creating 3D Elements Using Hyper Mesh, Element Quality and Checks, Compatibility and Mechanisms, General Element Quality Checks ,2D Quality Checks, Other Checks For 2D Meshing, Quality Checks for Tetra Meshes, Other Checks for Tetra Meshes, Brick Mesh Quality Checks, Other Checks for Brick Meshes, Mesh Check Tools in Hyper Mesh.   **12 Hours**

Course Outcomes:
- Student will learn about Finite Element Analysis (FEA) and will know to define manufacturing constraints.
- Student will know about Shell, Tetra, and Hyper Meshing.
- Student will be able to create hexa and penta mesh.
- Student will know to prepare models for analysis and geometry for meshing.
- Student will know to do 2D and 3D shape optimization and 1D and 2D size optimization.

E-Resources:
1. https://altairuniversity.com/wp-content/uploads/2012/04/HM_GUI_extract.pdf.
2. http://oss.jishulink.com/caenet/forums/upload/2008/04/05/2008830984180 00.pdf.
3. https://solidthinking.com/tutorials/solidThinking_8.0_Training_Course_eng.p df.

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Biomass Energy Systems

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET732	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PEC

Course Objectives:

This course will enable students to :

- Know the biomass sources of energy contents and the various biomass conversion methods.

- Understand conversion of biomass to bio fuels for combustion process.

- Study of bio mechanization process and calculation of bio gas digesters.

- Impart the knowledge of Bio fuels in IC engine combustion.

- Gain the knowledge in application of thermodynamics cycles in power generation

Syllabus

Module – I

Biomass Energy And Biomass Conversion Methods: Introduction, Biomass sources, Energy content of various Bio–fuels, Energy plantation, origin of Biomass, photosynthesis process, Biomass Characteristics, Sustainability of Biomass.

Biomass Conversion Methods: physical, agro chemical, thermo chemical, biochemical (flowchart) and explanation. Case studies. **08 Hours**

Module – II

Physical & Agrochemical Conversion: Briquetting, Pelletization**,** Agrochemical, fuel Extraction, Thermo chemical Conversion: Direct combustion for heat, domestic cooking & heating.

Biomass Gasification: Chemical reaction in gasification, Producer gas& the constituents, Types of Gasifiers: Fixed bed Gasifiers, Fluidized Gasifiers. 0**8 Hours**

Module – III

Liquefaction & Bio Mechanization: Liquefaction through pyrolysis & Methanol synthesis. Anaerobic digestion, Basic principles, factors influencing Biogas yield, classification of Biogas digester: floating gasholder & fixed dome type (Working Principle with diagram).Calculation for sizing of bio gas plant. **08 Hours**

Module – IV

Biogas For Power Generation: Ethanol as an automobile fuel, Ethanol production & its use in engines.

Bio Diesel: Bio Diesel from edible & non-edible oils, Production of Bio diesel from Honge& Jatropha seeds, use of bio diesel in I C engines, Engine power using Bio diesel, Blending of Biodiesel, Performance analysis of diesel engine. Effect of use of bio diesel in IC engines. Bio fuels for Transport & Power Generation; Biodiesel: History, Production methods of Biodiesel, Fuel quality, Standards & Properties, Availability of Raw Materials for biodiesel, Applications, Biodiesel potential in India.

08 Hours

Module – V

Bio Power Plants: Bio Power generation routes, Basic Thermodynamic cycles in Bio power generation; Brayton cycle, Sterling cycle, Rankine cycle, Co-generation cycle. Biomass based steam power plant. **08 Hours**

Course Outcomes:

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

- Describe the various biomass resources and its conversion methods
- Analyze the conversion of biomass to bio fuels for combustion process
- Demonstrate the concepts of bio meth nation process and biogas digester sizing
- Apply knowledge of bio fuels in IC Engine Combustion
- Evaluate the performance of biomass based steam power plant for power generation.

Text Books:

1. G.N.Tiwari&M.K.Goshal, "Renewable Energy Resources:Basic Principles &applications", Narosa Publishing House,Indian Editions, 2011, ISBN-13:9780071004992.

2. S.Rao&B.B. Panulkar: "Energy Technology", Khanna Publishers, Delhi-1999, 23rdReprintEdition, 2011, ISBN:9788189928469.

Reference Books:

1. Allan T. Kirkpatrick Colin R. Ferguson: "Internal Combustion Engine Applied Thermo sciences", Wiley India Pvt Ltd,1st Edition, 2008, ISBN: 9788126530076.

2. AyhanDemirbas, "Green Energy and Technology", Springer- Verlag London Limited, 1stEdition,2010, ISBN:978-1-84882-010-4.

E-resources:

1. http://nptel.ac.in/courses/108108078/7

2. http://nptel.ac.in/downloads/108108078/

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Automotive Electronics

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET733	3:0:0:0	3	CIE:50 SEE:50	3 Hours	PE

Course Objectives:

This course will enable students to :
- Understand the use of electronics in the automobile.
- appreciate the various electronic and the instrumentation systems used in automobile
- Study of Electronic engine control aspects.
- Impart the knowledge of fundaments of automobile control system.
- Gain the knowledge in automotive instrumentation system.

Syllabus

Module – I

Introduction to microcomputer: Microcomputer: Buses, memory, timing, CPU registers; Microprocessor architecture: Initialization, operation codes, program counter, branch and jump instructions, subroutine. Analog to digital converters and Digital to analog converters, sampling, polling and interrupts. digital filters, lookup table.   **09 Hours**

Module – II

Sensors and actuators: Speed sensors, Pressure sensors: Manifold Absolute Pressure sensor, knock sensor, Temperature sensors: Coolant and Exhaust gas temperature, Exhaust Oxygen level sensor, Position sensors: Throttle position sensor, accelerator pedal position sensor and crankshaft position sensor. Air mass flow sensor. Solenoids, stepper motors and relays.   0**9 Hours**

Module – III

Electronic engine management system: Electronic engine control: Input, output and control strategies, electronic fuel control system, fuel control modes: open loop and closed loop control at various modes, EGR control. Electronic ignition systems -Spark advance correction schemes, fuel injection timing control.   **09 Hours**

Module – IV

Electronic vehicle management system: Cruise control system. Antilock braking system, electronic suspension system, electronic steering control, traction control system, Transmission control, Safety: Airbags, collision avoiding system, low tire pressure warning system.   **09Hours**

Module – V

Automotive instrumentation system : Input and output signal conversion, multiplexing, fuel quantity measurement, coolant temperature and oil pressure measurement, display devices- LED, LCD, VFD and CRT, Onboard diagnostics(OBD), OBD-II, off board diagnostics. **09 Hours**

Course Outcomes:

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

- Describe the various parts of Microcomputer
- Demonstrate the concepts of Sensors and actuators
- Analyze the Electronic engine management system
- Apply knowledge of control system in automobile electronics
- Evaluate the performance of Automotive instrumentation system

Text Books:

1. Young A.P. & Griffiths. L. "Automotive Electrical Equipment", ELBS & New Press- 1999. ISBN 13: 9780592000404.

2. William B.Riddens "Understanding Automotive Electronics", 5th edition - Butter worth Heinemann Woburn, 1998. ISBN: 9780128104354.

3. Ganesan.V. "Internal Combustion Engines", Tata McGraw-Hill Publishing Co., New Delhi, 2003. ISBN 9780074621226

Reference Books:

1. Bechhold "Understanding Automotive Electronics", SAE, 1998. ISBN 9780128104347

2. Crouse, W.H, "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, 2015 ISBN 0442010699.

3. 3. Judge A.W, "Modern Electrical Equipment of Automobiles", Chapman & Hall, London, 1992. ISBN 978-94-011-6881-6.

E-resources:

1. https://nptel.ac.in/courses/107/106/107106088/

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Machine Learning for Mechanical Engineers

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET741	3:0:0:0	3	CIE:50 SEE:50	3 hours	MEP

Course Objectives:

- Acquire advanced Data Analysis skills.
- Stay Industry relevant and grow in your career.
- Create AI/ML solutions for various business problems.
- Build and deploy production grade AI/ML applications.
- Apply AI/ML methods, techniques and tools immediately

Syllabus

Module – I

Introducing Machine Learning:-Learn the basics of machine learning, including supervised and unsupervised learning, choosing the right algorithm, and practical examples. **08Hour**

Module – II

Getting Started with Machine Learning :- Step through the machine learning workflow using a health monitoring app as an example. The section covers accessing and loading data, pre-processing data, deriving features, and training and refining models.

09 Hours

Module – III

Applying Unsupervised Learning:-Explore hard and soft clustering algorithms, and learn about common dimensionality-reduction techniques for improving model performance. **09 Hours**

Module – IV

Applying Supervised Learning:- Explore classification and regression algorithms, and learn about techniques for model improvement, including feature selection, feature transformation, and hyper parameter tuning. **08Hours**

Module – V

Data Quality and Transformation:-Data imputation, Data Transformation (minmax, log transform, z-score transform etc.), Binning, Classing and Standardization, Outlier/Noise& Anomalies. **08 hours**

Course Outcomes:

Upon the completion of the course, the student should be able to,

- Develop an appreciation for what is involved in learning models from data.
- Understand a wide variety of learning algorithms.
- Understand how to evaluate models generated from data.
- Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models

Text Books:

1. EthemAlpaydin, Introduction to Machine Learning, Second Edition , http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012. This book will cover all the material in the course.

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Welding Technology

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET742	3:0:0:0	3	CIE:50 SEE:50	3	MEP

Course Objectives:

This course will enable students to:

- Understand and appreciate the objectives and uses of welding techniques and their operating types.
- Describe how resistance welding processes applied for an industry purpose.
- Evaluate the various types of solid state welding processes like friction and forged welding.
- Describe the various types of advanced welding processes like EBW and LBW.
- Understand the designing of welded joints.

Syllabus

Module – I

Gas And Arc Welding Processes:-Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electro slag welding processes - advantages, limitations and applications.   **09 Hours**

Module – II

Resistance Welding Processes: Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations and applications.   **08 Hours**

Module – III

Solid State Welding Processes: Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and hot pressure welding processes - advantages, limitations and applications.   **08 Hours**

Module – IV

Other Welding Processes: Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.   **08 Hours**

Module – V

Design of Weld Joints, Weldability and Testing of Weldments: Various weld joint designs – Weldability of Aluminium, Copper, and Stainless steels. Destructive and non-

destructive testing of weldments**.**   **07 Hours**

Course Outcomes:
On completion of this course, the students are able to:
- Gain the knowledge of various type of welding processes.
- Know the various types of resistance welding processes.
- Understand the operations of friction and forge welding processes
- Operate the welding processes like LASER beam and Electron beam processes.
- Know about the designing of various welded joints**.**

Text Books:
1. Parmer R.S., "Welding Engineering and Technology", 1st Edition, Khanna Publishers, New Delhi, 2008.
2. Little R.L., "Welding and Welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th Reprint, 2008
3. Nadkarni S.V. "Modern Arc Welding Technology", 1st Edition, Oxford IBH Publishers, 2005

Reference Books:
1. Schwartz M.M. "Metals Joining Manual". McGraw Hill Books, 1979.
2. Tylecote R.F. "The Solid Phase Welding of Metals". Edward Arnold Publishers Ltd. London, 1968.
3. AWS- Welding Hand Book. 8th Edition. Vol- 2. "Welding Process".
4. Christopher Davis. "Laser Welding- Practical Guide". Jaico Publishing House, 1994.
5. Davis A.C., "The Science and Practice Of Welding", Cambridge University Press, Cambridge, 1993

Resources:
1. https://nptel.ac.in/courses/112/107/112107090/

2. https://nptel.ac.in/courses/112/103/112103263/

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Solar Energy

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MET743	3:0:0:0	3	CIE:50 SEE:50	3 Hours	MEP

Course Objectives:

This course will enable students to:

- Know solar energy, its source and conversion technologies.
- Understand photovoltaic cell, design and their characteristics.
- Gain knowledge of different types of solar systems and estimation.
- Learn various solar energy based air heating systems and their applications.
- Study use of solar energy in space heating and cooling and their design considerations.

Syllabus

Module – I

Solar Energy: History and Current Use, Advantages of Solar Energy, Solar Energy Project Delivery Process, Integration of Solar Energy into the Existing Infrastructure. Solar Energy Resource: Structure of the Sun, Nuclear Fusion: The Source of the Sun's Power, The Spectral Nature of Solar Radiation, Position of the Sun in the Sky, Direct Beam, Diffuse, and Global Solar Insolation in the Plane of a Solar Collector Surface, Incident Angle of Direct Beam Sun on a Surface, The Effect of Shade, Solar Resource Measurement, Solar Resource Maps and Data, Typical Meteorological Year (TMY) Weather Data, Forecasting the Solar Resource Hours or Days into the Future, Diagnosis of Solar Energy System Performance Using Solar Resource Data, Computer Tools for Analysis of Solar Position and Solar Resources, Standards Related to Solar Resource Assessment. **08Hours**

Module – II

Photovoltaic's (PV, Solar Electricity): Photovoltaic Cells and Modules, Voltage and Current Characteristics of PV Devices (the i-v curve), Open-Circuit Voltage and Operating Voltage of a PV Cell, Dependence of Voltage and Current on Temperature, Different Types of Photovoltaic Devices, Standard Ratings and Performance Indicators for PV Modules, Energy Balance for a PV Module, Nominal Operating cell Temperature (NOCT), Power Output of a PV Module, Photovoltaic System Schematic Design, Photovoltaic System Components, Estimating the Cost of a Photovoltaic

System, Estimating Electric Use and Solar Fraction, Recommended Applications, Simple Hand Calculation of Photovoltaic System Size and Energy Delivery, Estimating the Energy Cost Savings of a Photovoltaic (Solar Electric) System, Computer Tools for Analysis of Photovoltaic Systems, Codes and Standards for Photovoltaic Modules and Systems, Operation and Maintenance of Photovoltaic Systems, Case Studies of Photovoltaic System Installations Procurement Specifications for Grid Tied Solar Electric (Photovoltaic) System   **07 Hours**
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Module – III
Solar Water Heating: Different Types of Water-Heating, Solar Collectors, Solar Water Heating System Schematic Design, Solar Water Heating System Components, Estimating the Cost of a Solar Water Heating System, Recommended Applications, Simple Hand Calculation of Solar Water Heating System Size and Energy Delivery, System Thermodynamics and Computer Tools for Analysis of Solar Water Heating Systems, Codes and Standards for Solar Water Heaters, Operation and Maintenance of Solar Water Heating Systems, Case Studies of Solar Water Heating System Installations, Procurement Specifications for a Solar Water Heating System.

09 Hours

Module – IV
Solar Ventilation Air Preheating: Operating Principle of the Transpired Air-Heating Solar Collector, Solar Ventilation Air Preheat System Schematic, Solar Ventilation Air Preheat System Components, Design Considerations, Recommended Applications, Estimating the Cost of a Solar Ventilation Air Preheat System, Simple Hand Calculations for Size and Performance of a Solar Ventilation Air Heating System, Computer Tools for Analysis of Solar Ventilation Preheat Systems, Codes and Standards related to Solar Ventilation Air Preheating, Maintenance of Solar Ventilation Air Preheating Systems, Case Studies of Solar Ventilation Air Preheating System Installations, Procurement Specifications for Solar Ventilation Preheat System **07 Hours**

Module – V
Solar Space Heating and Cooling: Site Issues, Building Heat Loss, Solar Heat Gain through Windows and Opaque Surfaces, Materials and Building Components for Passive Solar Space Heating Systems, Thermal Storage, Heat Distribution Systems, Solar Space Heating (Passive or Active), System Schematic Design, Estimating the Cost of a Solar Space Heating System, Estimating Energy Use and Solar Fraction, Calculation of Solar Space Heating System Sizing and Energy Delivery, Computer Tools for Analysis of Passive Solar Systems, Codes and Standards Related to Passive Solar Heating, Operation and Maintenance of Passive Solar heating Systems, Case Studies of Passive Solar Space Heating Systems, Procurement Specifications for Passive Solar Thermal Storage Wall.   **09 Hours**

Course Outcomes:
At the end of the course the student will be able to:
- Explain the types of solar energy conversion technologies.
- Describe photovoltaic cell their characteristics and their operation.
- Demonstrate different types of solar water heating, collectors, and estimation of cost.
- Identify various solar energy-based air heating systems and their applications.
- Discuss applications of solar energy in solar space heating and cooling.

Text Books:
1. Andy Walker, "Solar Energy Technologies and the Project Delivery Process for Buildings", Wiley, 2013, ISBN:9781118139240
2. Sukhatme S.P. "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2017, ISBN: 9789352607129.
3. 3. Tiwari G.N, "Solar Energy – Fundamentals Design, Modelling and applications", Narosa Publishing House, New Delhi, 2002, ISBN: 9781842658390

Reference Books:
1. John W. Twidell and Anthony D.Weir, 'Renewable Energy Resources,2013, ISBN: 9780415584388
2. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, John Wiley and Sons, 2013, ISBN: 9780471698678.
3. Soteris A. Kalogirou, Solar Energy Engineering: Processes and Systems", Academic Press, London, 2013, ISBN: 9780123972705.

E-Resources
1.https://nptel.ac.in/courses/112/105/112105050/

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Computer Aided Modeling and Analysis (CAMA)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEL75	2:0:0:0	2	CIE:50 SEE:50	03 Hours	PCC

Course Objectives:

This course will enable students to :

- Study different element types, properties and material models for modelling various structures.

- Understand the method of analyzing the bars, beams and trusses subjected to various forces.

- Develop skills for static and dynamic analysis of simple beams and bars.

- Gaining basic knowledge of analyzing the thermal problems like conduction and convection.

- Impart the knowledge of solving problems related to Air flow in pipe and on flat plate.

Syllabus

PART - A

Study of a FEA package and modeling stress analysis of

1. Bars of constant cross section area, tapered cross section area and stepped bar.

2. Trusses – in all three-coordinate system (Minimum 2 exercises).

3. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises).

PART - B

1. Stress analysis of a rectangular plate with a circular hole
2. Stress analysis of a bracket.
3. Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises).
4. Dynamic Analysis.
    - Fixed – fixed beam for natural frequency determination.
    - Bar subjected to forcing function.
    - Fixed – fixed beam subjected to forcing function.
    - Velocity Distribution of air flow on flat plate.
    - Analysis of air flow in pipe.   **11 Hours**

Course Outcomes:
Upon the completion of the course, the students will be able to:
• Select different element types, properties and material models to the different structures being analyzed.
• Do the stress analysis of bar, truss, beam and simple mechanical structures and validate the results with theoretical results.
• Carry out static and dynamic analysis of simple beams and bars.
• Analyze the thermal problems like conduction and convection using ANSYS.
• Carryout Air flow analysis of pipe and flat plate.

Reference Books:
1. A first course in the Finite element method, Daryl L Logan, Thomason, Third Edition.
2. Fundaments of FEM, Hutton – McGraw Hill, 2004.
3. Finite Element Analysis, George R. Buchanan, Schaum Series.

Scheme for Examination:
One Question from Part A :20 Marks (05 Write up +15)
One Question from Part B : 20 Marks (05 Write up +15)
Viva-Voce :1 0 Marks
Total :5 0 Marks

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Design Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19MEL76	2:0:0:0	2	CIE:50 SEE:50	3 hours	PCC

Course Objectives:
- To demonstrate the concepts discussed in Design of Machine Elements, Mechanical Vibrations & Dynamics of Machines courses.
- To visualize and understand the development of stresses in structural members and experimental determination of stresses in members utilizing the optical method of reflected photo-elasticity.

Syllabus

PART-A

1. Determination of natural frequency of a spring mass system.

2. Determination of natural frequency logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)

3. Determination of critical speed of rotating shaft.

4. Balancing of rotating masses.

PART-A

1. Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending).

2. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Hartnell Governor. 7. Determination of pressure distribution in Journal bearing

3. Experiments on Gyroscope (Demonstration only)

Course Outcomes:
Upon the completion of the course, the student should be able to,

- To practically relate to concepts discussed in Design of Machine Elements, Mechanical Vibrations & Dynamics of Machines courses.
- To measure strain in various machine elements using strain gauges and determine strain induced in a structural member using the principle of photo-elasticity.

Reference Books:

1. Richards G. Budynas and J. Keith Nisbett, "Shigley's Mechanical Engineering Design", McGraw-Hill Education, 10th Edition, 2015.

2. V.B. Bhandari, "Design of Machine Elements", TMH publishing company Ltd. New Delhi, 2nd Edition 2007.

3. Sadhu Singh, "Theory of Machines", Pearson Education, 2nd Edition, 2007.

4. G.K. Grover,"Mechanical Vibrations", NemChandand Bros, 6th Edition, 2006.

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Eighth Semester B.E. - Syllabus

Phase	Activity	Credits
II	Design, Theoretical/experimental investigation and Mid-term seminar to review the progress of the work and documentation (Mid term report).	4
III	Completion of the project work, participation in the project exhibition, Submission of project report Final Internal seminar and demonstration, Publications.	4
	Evaluation and Viva-voce	**5 + 5**

Program Educational Objectives (PEOs)

The graduates of Mechanical Engineering are expected to fulfill the following PEOs after a few years of their graduation.

PEO1	Graduates in Mechanical Engineering will apply the basic technical knowledge for design and analysis.
PEO2	Graduates in Mechanical Engineering will exhibit creative and innovative skills.
PEO3	Graduates in Mechanical Engineering will demonstrate good communication skills, dynamic leadership qualities with concern for environmental protection.
PEO4	Mechanical Engineering graduates will be capable of pursuing higher studies, take up research and development work blended with ethics and human values.
PEO5	Graduates in Mechanical Engineering will have the ability to become entrepreneurs thereby switching over from responsive engineering to creative engineering.

Program Outcomes (POs)

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and Mechanical Engineering principles to the solution of complex problems in Mechanical Engineering.
PO2	**Problem Analysis:** Identify, formulate, research interpretation, and analyze complex Mechanical Engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	**Design/Development of solutions:** Design solutions for complex Mechanical Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions related to Mechanical Engineering problems.

PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering tools such as CAD, CAM, CIM and FEM including prediction and modelling to complex Mechanical Engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional Mechanical Engineering practice.
PO7	**Environment and Sustainability:** Understand the impact of the professional Mechanical Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the Mechanical engineering practice. .
PO9	**Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex Mechanical engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.