GUJARAT TECHNOLOGICAL UNIVERSITY

ADVANCE ENGINEERING MATHS
SUBJECT CODE: 2130002
B.E. 3RD SEMESTER

Type of course: Engineering Mathematics

Prerequisite: The course follows from Calculus, Linear algebra

Rationale: Mathematics is a language of Science and Engineering

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	2	0	5	70	20	10	30	0	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Introduction to Some Special Functions:** Gamma function, Beta function, Bessel function, Error function and complementary Error function, Heaviside's function, pulse unit height and duration function, Sinusoidal Pulse function, Rectangle function, Gate function, Dirac's Delta function, Signum function, Saw tooth wave function, Triangular wave function, Halfwave rectified sinusoidal function, Full rectified sine wave, Square wave function.	02	4
2	**Fourier Series and Fourier integral:** Periodic function, Trigonometric series, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion, Forced oscillations, Fourier integral	05	10
3	**Ordinary Differential Equations and Applications:** First order differential equations: basic concepts, Geometric meaning of $y' = f(x,y)$ Direction fields, Exact differential equations, Integrating factor, Linear differential equations, Bernoulli equations, Modeling , Orthogonal trajectories of curves.Linear differential equations of second and higher order: Homogeneous linear differential equations of second order, Modeling: Free Oscillations, Euler- Cauchy Equations, Wronskian, Non homogeneous equations, Solution by undetermined coefficients, Solution by variation of parameters, Modeling: free Oscillations resonance and Electric circuits, Higher order linear differential equations, Higher order homogeneous with constant coefficient, Higher order non homogeneous equations. Solution by [1/f(D)] r(x) method for finding particular integral.	11	20
4	**Series Solution of Differential Equations:** Power series method, Theory of power series methods, Frobenius method.	03	6
5	**Laplace Transforms and Applications:** Definition of the Laplace transform, Inverse Laplace transform, Linearity, Shifting theorem, Transforms of derivatives and integrals Differential equations, Unit step function Second shifting theorem,	09	15

	Dirac's delta function, Differentiation and integration of transforms, Convolution and integral equations, Partial fraction differential equations, Systems of differential equations		
6	**Partial Differential Equations and Applications:** Formation PDEs, Solution of Partial Differential equations f(x,y,z,p,q) = 0, Nonlinear PDEs first order, Some standard forms of nonlinear PDE, Linear PDEs with constant coefficients,Equations reducible to Homogeneous linear form, Classification of second order linear PDEs.Separation of variables use of Fourier series, D'Alembert's solution of the wave equation,Heat equation: Solution by Fourier series and Fourier integral	12	15

Reference Books:

1. Advanced Engineering Mathematics (8th Edition), by E. Kreyszig, Wiley-India (2007).
2. Engineering Mathematics Vol 2, by Baburam, Pearson
3. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005)
4. R. V. Churchill and J. W. Brown, Fourier series and boundary value problems (7th Edition), McGraw-Hill (2006).
5. T.M.Apostol, Calculus , Volume-2 (2nd Edition), Wiley Eastern , 1980

Course Outcome:

After learning the course the students should be able to

1. Fourier Series and Fourier Integral
   - Identify functions that are periodic. Determine their periods.
   - Find the Fourier series for a function defined on a closed interval.
   - Find the Fourier series for a periodic function.
   - Recall and apply the convergence theorem for Fourier series.
   - Determine whether a given function is even, odd or neither.
   - Sketch the even and odd extensions of a function defined on the interval [0,L].
   - Find the Fourier sine and cosine series for the function defined on [0,L]
2. Ordinary Differential Equations and Their Applications
   - Model physical processes using differential equations.
   - Solve basic initial value problems, obtain explicit solutions if possible.
   - Characterize the solutions of a differential equation with respect to initial values.
   - Use the solution of an initial value problem to answer questions about a physical system.
   - Determine the order of an ordinary differential equation. Classify an ordinary differential equation as linear or nonlinear.
   - Verify solutions to ordinary differential equations.
   - Identify and solve first order linear equations.
   - Analyze the behavior of solutions.
   - Analyze the models to answer questions about the physical system modeled.
   - Recall and apply the existence and uniqueness theorem for first order linear differential equations.
   - Identify whether or not a differential equation is exact.
   - Use integrating factors to convert a differential equation to an exact equation and then solve.
   - Solve second order linear differential equations with constant coefficients that have a characteristic equation with real and distinct roots.
   - Describe the behavior of solutions.
   - Recall and verify the principal of superposition for solutions of second order linear differential equations.
   - Evaluate the Wronskian of two functions.

- Determine whether or not a pair of solutions of a second order linear differential equations constitute a fundamental set of solutions.
- Recall and apply Abel's theorem.
- Apply the method of reduction of order to find a second solution to a given differential equation.
- Apply the method of undetermined coefficients to solve non-homogeneous second order linear differential equations.
- Model undammed mechanical vibrations with second order linear differential equations, and then solve. Analyze the solution. In particular, evaluate the frequency, period, amplitude, phase shift, and the position at a given time.
- Define critically damped and over damped. Identify when these conditions exist in a system.
- Describe the phenomena of beats and resonance. Determine the frequency at which resonance occurs.
- Recall the definition of linear independence for a finite set of functions. Determine whether a set of functions is linearly independent or linearly dependent.
- Use the method of variation of parameters to solve non-homogeneous higher order linear differential equations.

3. Series Solution of Differential Equations

- Manipulate expressions involving summation notation. Change the index of summation.
- Find the general solution of a differential equation using power series.
- Given an initial value problem, use the differential equation to inductively determine the terms in the power series of the solution, expanded about the initial value.

4. Laplace Transforms and Applications

- Sketch a piecewise defined function. Determine if it is continuous, piecewise continuous or neither.
- Evaluate Laplace transforms from the definition.
- Determine whether an infinite integral converges or diverges.
- Evaluate inverse Laplace transforms.
- Use Laplace transforms to solve initial value problems.
- Convert piecewise defined functions to functions defined in terms of step functions and vice versa.
- Find the Laplace transform of a piecewise defined function.
- Apply the shifting theorems to evaluate Laplace transforms and inverse Laplace transforms.
- Use Laplace transforms to solve differential equations with discontinuous forcing functions.
- Define an idealized unit impulse function.
- Use Laplace transforms to solve differential equations that involve impulse functions.
- Evaluate the Laplace transform of a convolution of functions.
- Use the convolution theorem to evaluate inverse Laplace transforms.

5. Partial Differential Equations and Applications

- Determine the order of a partial differential equation.
- Classify a partial differential equation as linear or nonlinear.
- Verify solutions to partial differential equations.
- Apply the method of separation of variables to solve partial differential equations, if possible.
- Find the solutions of heat conduction problems in a rod using separation of variables.
- Solve steady state heat conduction problems in a rod with various boundary conditions.
- Solve the wave equation that models the vibration of a string with fixed ends.
- Describe the motion of a vibrating string.

- Solve Laplace's equation over a rectangular region for various boundary conditions.
- Solve Laplace's equation over a circular region for various boundary conditions.

List of Open Source Software/learning website:

1. NPTEL
   http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Signals%20and%20System/Course_home4.30
   https://www.youtube.com/watch?v=DPg5T-YBQjU
   https://www.youtube.com/watch?v=7fJeo1fylKI
   https://www.youtube.com/watch?v=1FnBPmEWpus
   https://www.youtube.com/watch?v=dgDIQ0VA0pA
   https://www.youtube.com/watch?v=SoBs-YGQUdc
   https://www.youtube.com/watch?v=Fh8m6ZdFaqU

2. **Instructor(s):** Prof. Haynes Miller, Prof. Arthur Mattuck

   http://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/

3. **Instructor:** Prof. Haynes Miller, Prof. Arthur Mattuck, Dr. John Lewis

   http://ocw.mit.edu/courses/mathematics/18-03sc-differential-equations-fall-2011/

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICS OF SOLIDS
SUBJECT CODE: 2130003
B.E. 3RD SEMESTER

Type of course: Applied Physics

Prerequisite: System of units
Laws of motion
Basic idea of force
Concept of centroid
Fundamentals of stress, strain and their relationships

Rationale: Mechanics of Solids is conceptual applications of principles of mechanics in Engineering

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Sr. No.	Topics	Teaching Hrs.	Module Weightage
	Module 1		
1	**Introduction** Definition of space, time, particle, rigid body, deformable body. Force, types of forces, Characteristics of a force, System of forces, Composition and resolution of forces. Fundamental Principles of mechanics: Principle of transmissibility, Principle of superposition, Law of gravitation, Law of parallelogram of forces.	02	20
2	**Fundamentals of Statics** **Coplanar concurrent and non-concurrent force system:** Resultant, Equilibrant, Free body diagrams. **Coplanar concurrent forces:** Resultant of coplanar concurrent force system by analytical and graphical method, Law of triangle of forces, Law of polygon of forces, Equilibrium conditions for coplanar concurrent forces, Lami's theorem. Application of statically determinate pin – jointed structures. **Coplanar non-concurrent forces:** Moments & couples, Characteristics of moment and couple, Equivalent couples, Force couple system, Varignon's theorem, Resultant of non-concurrent forces by analytical method, Equilibrium conditions of coplanar non-concurrent force system, Application of these principles.	08	
	Module 2		
3	**Applications of fundamentals of statics**	08	15

	Statically determinate beams: Types of loads, Types of supports, Types of beams; Determination of support reactions, Relationship between loading, shear force & bending moment**,** Bending moment and shear force diagrams for beams subjected to only three types of loads :i) concentrated loads ii) uniformly distributed loads iii) couples and their combinations; Point of contraflexure, point & magnitude of maximum bending moment, maximum shear force.		
Module 3			
4	**Friction** Theory of friction, Types of friction, Static and kinetic friction, Cone of friction, Angle of repose, Coefficient of friction, Laws of friction, Application of theory of friction: Friction on inclined plane, ladder friction, wedge friction, belt and rope friction.	06	20
5	**Centroid and moment of inertia** **Centroid:** Centroid of lines, plane areas and volumes, Examples related to centroid of composite geometry, Pappus – Guldinus first and second theorems. **Moment of inertia of planar cross-sections:** Derivation of equation of moment of inertia of standard lamina using first principle**,** Parallel & perpendicular axes theorems, polar moment of inertia, radius of gyration of areas. Examples related to moment of inertia of composite geometry,	08	
Module 4			
6	**Simple stresses & strains** Basics of stress and strain: 3-D state of stress (Concept only) Normal/axial stresses: Tensile & compressive Stresses :Shear and complementary shear Strains: Linear, shear, lateral, thermal and volumetric. Hooke's law, Elastic Constants: Modulus of elasticity, Poisson's ratio, Modulus of rigidity and bulk modulus and relations between them with derivation. Application of normal stress & strains: Homogeneous and composite bars having uniform & stepped sections subjected to axial loads and thermal loads, analysis of homogeneous prismatic bars under multidirectional stresses.	10	20
Module 5			
7	**Stresses in Beams:** **Flexural stresses –** Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses, section modulus of rectangular & circular (solid & hollow), I,T,Angle, channel sections **Shear stresses –** Derivation of formula, shear stress distribution across various beam sections like rectangular, circular, triangular, I, T, angle sections.	06	25
8	**Torsion:** Derivation of equation of torsion, Assumptions, application of theory of torsion equation to solid & hollow circular shaft, torsional rigidity.	04	

9	**Principle stresses:** Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications	04	
Module –VI			
10	**Physical & Mechanical properties of materials: (laboratory hours)** Elastic, homogeneous, isotropic materials; Stress –Strain relationships for ductile and brittle materials, limits of elasticity and proportionality, yield limit, ultimate strength, strain hardening, proof stress, factor of safety, working stress, load factor, Properties related to axial, bending, and torsional & shear loading, Toughness, hardness, Ductility ,Brittleness	05	50% (Practical) & 0% (Theory)
11	**Simple Machines: (laboratory hours)** Basics of Machines, Definitions: Velocity ratio, mechanical advantage, efficiency, reversibility of machines. Law of Machines, Application of law of machine to simple machines such as levers, pulley and pulley blocks, wheel and differential axle, Single purchase, double purchase crab, screw jacks. Relevant problems.	05	

Course Outcome:

After learning the course the students should be able to:

1. apply fundamental principles of mechanics & principles of equilibrium to simple and practical problems of engineering.
2. apply principles of statics to determine reactions & internal forces in statically determinate beams.
3. determine centroid and moment of inertia of a different geometrical shape and able to understand its importance.
4. know basics of friction and its importance through simple applications.
5. understand the different types of stresses and strains developed in the member subjected to axial, bending, shear, torsion & thermal loads.
6. know behaviour & properties of engineering materials.
7. know basics of simple machines and their working mechanism.

List of Experiments:

The students will have to solve atleast five examples and related theory from each topic as an assignment/tutorial. Students will have to perform following experiments in laboratory and prepare the laboratory manual.

Mechanics of rigid body

1. Equilibrium of coplanar concurrent forces
2. Equilibrium of coplanar non-concurrent forces
3. Equilibrium of coplanar parallel forces: Determination of reactions of simply supported beam
4. Verification of principle of moment: Bell crank lever
5. Determination of member force in a triangular truss
6. Determination of coefficient of static friction using inclined plane
7. Determination of parameters of machines (Any two)

(a) Wheel and differential axles
(b) Single purchase crab
(c) Double purchase crab
(d) System of pulleys

Mechanics of deformable body

8. Determination of hardness of metals: Brinell /Vicker/Rockwell hardness test
9. Determination of impact of metals: Izod/Charpy impact test
10. Determination of compression test on
    (a) Metals – mild steel and cast iron
    (b) Timber – along and parallel to the grains
11. Determination of tensile strength of metals
12. Determination of shear strength of metals

Design based Problems (DP): (any two)

1. For a real industrial building having roof truss arrangement, (a) take photograph & identify type of truss, (b) draw sketch of truss with all geometrical dimension, cross sections details, type of joints, type of support conditions (c) prepare a model of truss (d) identify & determine types of load acts on it (d) determine support reactions & member forces due to dead load & live load only.
2. Take a case of the Mery-Go-Round used in the fun park. Draw its sketch showing radius of wheel, no of seats, capacity of each seats and other related information. Determine the amount of resultant produced at the centre of wheel during rest position, when (i) it is fully loaded (2) it is 30% loaded with symmetric arrangement. Draw support arrangement and determine support reactions. Also determine amount of torque required to start its operation.
3. Prepare working models for various types of beams with different shape of cross section, supporting conditions and study the effect of cross section on the deflection of beams.
4. Prepare working model of simple lifting machine using different types of pulley systems and calculate various parameters like load factor, velocity ratio, law of machine, efficiency of machine etc.

Major Equipments:

1. Force table
2. Beam set up
3. Truss set up
4. Bell crank lever
5. Friction set up
6. Lifting machine
7. Hardness testing machine
8. Impact testing machine
9. Universal testing machine with shear attachment

List of Open Source Software/learning website:
www.nptel.iitm.ac.in/courses/

Active learning Assignments (AL) : Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will

allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

DESIGN ENGINEERING
SUBJECT CODE: 2130005

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks			Practical Marks		
L	T	P	C	ESE (E)	PA (M)		PA (V)	PA (I)	
					PA	ALA	ESE		
0	0	3	3	0	0	0	80	20	100

Design Engineering 1, 2 and 3

What is design? Design is a plan of a system, its implementation and utilization for attaining a goal. It is to change undesired situation into desired situation means to find solution for undesired/uncomfortable situation.
Designs can be for
(1) Technical systems (power plant)
(2) Educational systems (Montessori Method)
(3) Aesthetic systems (logo designs, advertisements)
(4) Legal systems
(5) Social, religious or cultural systems
(6) Theories, Models, etc.

Design thinking gives students a taste of the rich internal-remunerations associated with knowledge-creation and in curiosity and problem-driven contexts. Design need to satisfy technical functions, ergonomics functions, aesthetic functions, cost function and environment functions.

Essential features of Design:
Design solution of a problem starts with planned constructions for achieving goal/s. Designing means evolving goal oriented processes. At the beginning of the design process only goals are known while at the end, both the goals and plans are known and that to with more clarity. Goal and plans evolve together and they influencing each other. In designing process some goals are more important than others and similarly some plans are better than others. Designing does not guarantee that the design will work.

Design thinking process:
(1) Find goals or need
(2) Evaluate goals or need
(3) Generate proposals to satisfy goals
(4) Evaluate proposals
(5) Improve goals and proposals

Teaching methodology:
The design engineering should be with fun and should create excitement. It should be integrated theme across the various courses. It should promote the team work. Design is thinking and doing. The complete design process should be included in design engineering 1, 2 and 3. The prototype design must consider technical, aesthetic, ergonomics, cost and environmental requirements.

Content:

Design Engineering 1: (3 credits in Semester 3, 3 credits in Semester 4)
Introduction to product innovation process (Need-requirement-concept-detail-prototype-services-business)
Modules on: Task clarification and conceptualization: Problem-idea-solution-evaluation

- Problem identification
- Ideation
- Consolidation
- Evaluation

Project: identifying need to developing proof of concept to demonstrate solution selected

Students can tackle simple design problems with engineering content – posed by the teacher or based on a survey of real life concerns of the public. The second is more effective – the students "own the problem" - but has to be accepted by the teacher.

Examples: (a) A device to help carry heavy luggage to the upper floors of a building – a building that has no lifts. (b) Systems to ensure that water does not come out as a jet from the taps in the lower floors of a tall building. One can insist on multiple realistic solutions and all should be part of the submission along with statements of their shortcomings or advantages. Teacher should not entertain fancy solutions – based on fancy ideas - with no engineering or scientific basis.

Short lectures on the topics in the syllabus should parallel the activity.

Design Engineering 2: (3 credits in Semester 5, 3 credits in Semester 6)
Introduction to detail design
Modules on

- Design for performance, safety, reliability
- Design for ergonomics and aesthetics
- Design for manufacturability
- Design for cost, environment

Project: developing the concept into a detailed design with a functional prototype

Here one could ask students to develop products based on themes - "Garbage compactors, Energy from kitchen waste, etc" making sure that the problems identified by the students within the themes possess an engineering content and insisting on some facets of design for assembly, for manufacturability, ...and so on while preparing the design and the prototypes. One could encourage students to innovate, arrive at multiple solutions and conduct a detailed design of one of the solutions.

Prototyping requires funds and effort, so it pays to identify one subsystem of the design of the whole machine. One can insist on prototyping demonstrating at least that sub-system, if not the whole system.

Design Engineering 3: (3 credits in Semester 7, 3 credits in Semester 8)
Introduction to services and business planning
Modules on

- Design of services
- Intellectual property
- Materials and recourse planning
- Business planning

Project: developing a business model

OR

Research or Technology Development project
Modules on

- Detailed literature survey and to find out technology gap
- Intellectual property
- Re-evaluate prototype of DE-2 and proposal of novel idea

Project: developing a novel functional prototype

GUJARAT TECHNOLOGICAL UNIVERSITY

AUTOMOBILE ENGINEERING (02) /MECHANICAL ENGINEERING (19)

MANUFACTURING PROCESSES – I

SUBJECT CODE: 2131903

B.E. 3RD SEMESTER

Type of Course: Engineering

Prerequisite: Zeal to learn the subject

Rationale: Manufacturing processes related to machining are included in this subject. All conventional machines are included in this course to understand the basic concepts in machining science.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	Basic Machine Tools and Metal Cutting Principles: Machine tools classification, working and auxiliary motions in machine tools, Primary cutting motions in machines tools, Cutting tool geometry and tool signature, cutting forces and power requirement in machining	4	8%
2.	Metal Cutting Lathes: Engine Lathes, construction all arrangement and principal units of engine lathes, type and size range of engine lathes, Operations carried on engine lathe , attachment extending the processing capacities of engine lathes, Types of lathe machines, Capstan and Turret lathes, Taper turning on lathe, Thread cutting on lathe using gear train and chasing dial, Alignment tests of lathes.	11	22%
3	Drilling Machines: Purpose and field of application of drilling machines, Types of drilling machines, Drilling and allied operation: drilling, boring, reaming, tapping, counter sinking, counter boring, spot facing; deep hole drilling, alignment tests of drilling machine.	6	12%
4.	Boring Machine: Purpose and filed of application, Horizontal boring machines, Precision boring machines.	3	6%
5.	Milling Machines: Purpose and types of milling machines, general purpose milling machines, different types of milling operations, milling cutters, attachments extending the processing capabilities of general	11	22%

	purpose milling machines, Indexing, Helical milling operation and its set up, Alignment tests of milling machine.		
6.	Planers, Shapers and Slotters: Classification of milling machine, Attachments extending the processing capacities of milling machine, machine and tooling requirements	6	12%
7.	Sawing and Broaching Machines: Metal sawing classification: reciprocating sawing machines, circular sawing machines, band sawing machines, Types of broaching machines, advantage and limitations of broaching.	3	6%
8.	Grinding Machines and Abrasives: Classification of grinding machines, cylindrical grinders, internal grinders, Surface grinders, tool and cutter grinders, center less grinders, Types of grinding wheels, wheel characteristics and wheel selection.	6	12%

Reference Books:

1. Workshop Technology Vol. I, II & III, WAJ Chapman.
2. Workshop Technology Vol. II, Hajra & Choudhari.
3. Manufacturing Processes, O.P. Khanna.
4. Production Technology, R. K. Jain.
5. Processes and Materials of Manufacture; Lindberg Roy A.; Prentice-Hall India.
6. Principles of Manufacturing Materials and Process, J S Campbell.

Course Outcomes:

At the end of this course students will be able to:
1. Understand the basic concept of machining operations.
2. Analyze any conventional machining processes.
3. Generate the sequence of machining operation to produce the end product.
4. Judge the limitations and scope of machines to perform variety of operations.

List of Practical:

1. Study of Machine Tools (Lathe, Shaper, Slotter, Planner) – study the types of cutting tools available and relative motions between cutting tool and work piece on each machine tool. Also derive capacity and capability of respective machine tools from machine specifications and number of available attachments to perform variety of operations.
2. Study of Machine Tools (Grinding, Milling, Drilling) – study the types of cutting tools available and relative motions between cutting tool and work piece on each machine tool. Also derive capacity and capability of respective machine tools from machine specifications and number of available attachments to perform variety of operations.
3. Job making on lathe machine
4. Job making on shaper / slotter machine
5. Job making on milling machine
6. Job making on Drilling machine
7. Job making on Grinding machine
8. Alignment test on lathe machine / any other machine

Students will be performing the actual machining operation on respective machines in groups or individually with the help or guidance of Lab technician.

Open Ended Problem:

1. Develop a simplest possible Tool Dynamometer to determine the force the tool exerts on the work piece in a lathe.
2. Develop a machine to make holes in very soft material.
3. A precise hole is to be drilled in a rod of circular cross section at a specified distance from the end of the rod. Thousands of such parts are required. Develop a jig or fixture to ensure that all the pieces are identical.
4. Develop a machine to make corrugated metal sheet.
5. Gold of very thin gage is to be used to cover the body of a Rolls Royce car. Design a process/machine to make such a thin gage and demonstrate using any easily available material
6. Students may be asked to provide a design set up for machining any component / product on any of the conventional machine studied in this course. Moreover, a detailed sketch of each of the operations in a proper sequence on a specific machine or different machine may also be derived by student to conclude an appropriate design.

Major Equipments:

All conventional machine tools such lathe, milling, shaper, slotter, drilling machine, grinder, etc.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

AUTOMOBILE ENGINEERING (02) /MECHANICAL ENGINEERING (19)

MATERIAL SCIENCE & METALLURGY

SUBJECT CODE: 2131904

B.E. 3RD SEMESTER

Type of Course: Engineering

Prerequisite: Zeal to learn the subject

Rationale: Basic principles of science are used to study the structure-properties relationships of various materials for their proper applications in this subject. Especially study of different types of ferrous and non-ferrous metals and alloys, in terms of their composition, structure, properties and applications; non-destructive testing are included in this course to understand the basic concept of selection and processing of metals and materials for their applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	Introduction to Material Science Metallurgy: Classification of Engineering Materials, Engineering requirements of materials, , Criterion for selection of materials for engineering applications through Structure-Properties-Performance correlationship; Introduction to levels of internal structure like macro, micro, crystal and atomic and their correlated properties; Methods/Tools to reveal the different levels of structure.	3	5%
2.	Crystal geometry and Crystal Imperfections: Unit Cell, Crystal structure, Bravise lattice, atomic packing, coordination number, crystal structures of metallic elements, crystal directions and planes, Miller indices, Polymorphism or Allotropy. Crystal structure and correlated properties. diffusion processes; Crystallization: Mechanism of crystallization – nucleation and growth, factors influencing nucleation and growth Imperfections in crystals and their effect on properties, Solute strengthening	5	8%
3.	Plastic Deformation: Deformation by slip, Mechanism of slip, Slip in different lattice structures, Deformation by twinning, Strain hardening , Effect of strain hardening on properties, Recovery, Recrystallization and Grain Growth and their effect on properties of ductile metals.	3	5%
5.	Solidification of metals and an alloy, Nucleation and Growth during freezing of pure metal and alloy ingot/a casting Resultant macrostructures; Effects of Structure on Mechanical Properties, Methods to control the grain structure resulting from solidification, Solidification defects like porosity and shrinkage and remedies.	4	7%
6.	Phase and Phase equilibrium: Unary and Binary equilibrium phase diagrams, Gibb's free energy for thermodynamic stability of phases, Gibb's phase rule, solid solutions and compounds, Hume-Rothery rules; cooling curves, lever rule, Different reactions like eutectic, eutectoid, peritectic and peritectoid; Non-equilibrium cooling;	3	9%

7.	Allotropy of Iron, Iron-Iron-Carbide equilibrium system-phases and their properties of the Iron-Iron Carbide equilibrium diagram, different reactions of the Iron-Iron Carbide equilibrium system, Alloy groups (Wrought Irons, Steels and Cast Irons) of Iron-Iron Carbide equilibrium system and their characteristics in general, Equilibrium cooling of eutectoid, hypoeutectoid and hypereutectoid steels, their resultant microstructures and hence correlated properties and applications. . IS and ISO Codification, Different specifications and designations of steels	5	15%
8.	Heat Treatment of Steels: Time-Temperature-Transformation Diagram, Isothermal and continuous transformations; Austenitic grain size control/grain refinement, study of effects like temper-brittleness, overheating and burning of steels Study of Heat-Treatment processes with heat treatment cycles for plain C steels such as Different types of Annealing, Normalizing, hardening and tempering, full hardening and case hardening methods; Applications of above processes for the industrial practices.	5	15%
9.	Alloy steels: Purpose of alloying; General effect of alloying elements on ferrite, carbide, transformation temperature, hardenability and tempering. Types: Chromium, Manganese, Molybdenum and Manganese steels. IS Codification. Tool Steels: Classification, properties, applications and IS and ISO Codification.	2	5%
10.	Cast Iron: Iron-Iron Carbide and Iron-carbon diagrams, Transformations resulting into White Cast Iron, Grey Cast Iron, Malleable Cast Iron, S. G. Iron, Alloy Cast Iron. Their microstructures and correlated properties and applications. IS Codification.	3	6%
12.	Non-ferrous alloys: alloys of copper, aluminium, magnesium titanium. Other alloys of lead, tin, zinc, nickel, manganese, white metals and bearing alloys.	3	6%
13	Powder Metallurgy: Application and advantages, Production of powder, Compacting, Sintering, Equipment and process capability.	3	5%
14	Non Destructive testing of materials such as Radiography Testing, Dye Penetration Testing, Magnetic Particle Testing, Ultrasonic Testing. Eddy current testing with their Principle of non-destructive testing, the test methods, relative merits, demerits and applications.	4	10%
15.	Metallography: Structure of Metals, Macro-examination: Macro-etching; Microscopic examinations: Specimen Preparation, etching, grain size measurement; Chemical analysis of steel and Iron for Carbon, Sulphur & Phosphorous.	*	4%

*** Topic should be cover during laboratory session only.**

References:

1. Callister's Material Science and Engineering, 2/e R. Balasubramaniam, Wiley India.
2. Elements of Material Science and Engineering, 6/e, Lawrence H. Van Vlack, Pearson Education.
3. The Science and Engineering of Materials 6/e, Donald R. Askeland and Pradeep P. Phule, Cengage Learning.
4. Principles of Materials Science and Engineering, W F Smith, McGraw Hill.
5. Materials Science and Metallurgy, K. I. Parashivamurthy, Pearson Education.
6. Physical Metallurgy, Sydney H. Avner, Tata McGraw-Hill.
7. Practical Non-Destructive Testing, Baldev Raj, T. Jayakumar and M. Thavasimuthu, Narosa Pub. House.
8. ASM Handbook Vol. 9: Metallography and Microstructure, Ed. George F. Vander Voort, ASM International 2004.

Course Outcomes: At the end of this course students will be able to:

1. Understand the basic concept of Material Science and Metallurgy.
2. Know about the ferrous and non ferrous metals and alloys and their applications.
3. Understand different non-destructive testing methods.
4. Find the causes and prevention of metallic corrosion.
5. Judge the Scope and limitations of different materials.

List of Practical:

1. To get acquainted with the operation, construction, use and capabilities of a metallographic microscope
2. To study procedure of specimen preparation for microscopic examination and to carry out a specimen preparation.
3. To understand what is micro examination, importance of micro examination and to study various ferrous, non-ferrous microstructures.
4. To identify the different types of material available for design, manufacturing and processing of various components based on structure-property-performance-processing relationships.
5. To show the effect of different quenching media (Oil, Water and Brine) on the hardness of medium carbon steel.
6. To understand the concept of hardenability and its relevance to heat treatment procedure to be adopted in practice.
7. To find out the effect of varying section size on hardenability of steel and obtain hardness distribution curves of hardened steel cross-section.
8. Study of different heat treatment processes- annealing, normalizing, hardening and tempering, surface and casehardening to improve properties of steel during processes and applications.
9. To understand the procedure of testing, nature of indication, the capability and sensitivity of the liquid penetrant test and the magnetic particle test.
10. To understand the procedure of testing, nature of indication, the capability and sensitivity of the Eddy current test and the Ultrasound test.

Open Ended Problem:

1. Design a machine / evolve a procedure to manufacture porous/spongy metals and demonstrate the same.
2. Design a bimetallic strip to be used as a thermostat.
3. Design a machine to determine friction coefficient between two metals. One of the materials is available in the form of 5mm dia. pins.
4. Develop an experimental setup/apparatus to determine thermal critical point of a metal.
5. Design a machine to determine the strength of Bamboo - tension, compression.
6. Students may be asked for metallography to prepare specimens for microstructure analysis. Moreover they may be asked to provide design of heat treatment cycles of specific types of steels for their applications, e.g., design heat treatment cycle for tool steel.
7. Students may be asked to choose a material for given application based on structure-property-performance relationship. Also they should give specification and designation of a chosen material.

Major Equipment: Metallurgical microscope with computerized image analysis system, Standard specimen set of steel, cast iron and non- ferrous metals and alloys, Spectrometer, Muffle furnace, standard specimens of steels and cast iron for heat treatment, Hardness tester, Universal tensile testing machine.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the

students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

AUTOMOBILE ENGINEERING (02) /MECHANICAL ENGINEERING (19)

ENGINEERING THERMODYNAMICS

SUBJECT CODE: 2131905

B.E. 3RD SEMESTER

Type of course: Engineering Science

Prerequisite: Zeal to learn the subject

Rationale: Engineering Thermodynamics is the first course on Thermal Science and Engineering. It studies various energy interactions notably heat and work transfer. It is based on certain laws of nature which are never seen to be violated.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	1	0	5	70	20	10	30	0	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	Basic Concepts: Microscopic & macroscopic point of view, thermodynamic system and control volume, thermodynamic properties, processes and cycles, Thermodynamic equilibrium, Quasi-static process	4	25%
2	First law of Thermodynamics: First law for a closed system undergoing a cycle and change of state, energy, PMM1, first law of thermodynamics for steady flow process, steady flow energy equation applied to nozzle, diffuser, boiler, turbine, compressor, pump, heat exchanger and throttling process, filling and emptying process	5	
3	Second law of thermodynamics: Limitations of first law of thermodynamics, Kelvin-Planck and Clausius statements and their equivalence, PMM2, causes of irreversibility, Carnot theorem, corollary of Carnot theorem, thermodynamic temperature scale	6	
4	Entropy: Clausius theorem, property of entropy, inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy, entropy change for non-flow and flow processes, third law of thermodynamics	5	25%
5	Energy: Energy of a heat input in a cycle, exergy destruction in heat transfer process, exergy of finite heat capacity body, exergy of closed and steady flow system, irreversibility and Gouy-Stodola theorem and its applications, second law efficiency	9	
6	Vapor Power cycles: Carnot vapor cycle, Rankine cycle, comparison of Carnot and Rankine cycle, calculation of cycle efficiencies, variables affecting efficiency of Rankine cycle, reheat cycle, regenerative cycle, reheat-regenerative cycle, feedwater heaters,	10	40%
7	Gas Power cycles: Recapitulation of Carnot, Otto and Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, air standard	10	

	efficiency, mean effective pressure, brake thermal efficiency, relative efficiency, Brayton cycle, effect of reheat, regeneration, intercooling and turbine and compressor efficiency on Brayton cycle		
8	Properties of gases and gas mixtures: Avogadro's law, equation of state, ideal gas equation, Vander Waal's equation, reduced properties, law of corresponding states, compressibility chart, Gibbs-Dalton law, internal energy; enthalpy and specific heat of a gas mixtures	7	10%

Reference Books:

1. Engineering Thermodynamics by P.K. Nag, McGraw-Hill Education
2. Fundamentals of Thermodynamics by Borgnakke & Sonntag, 7th Ed. Wiley India (P) Ltd.
3. Thermodynamics – An Engineering Approach by Yunus Cengel & Boles, McGraw-Hill Education
4. Engineering Thermodynamics by Gordon Rogers and Yon Mayhew, Pearson Education Ltd.
5. Engineering Thermodynamics by Krieth, CRC Press
6. Engineering Thermodynamics by Jones and Dugan, PHI Learning Pvt. Ltd.

Course Outcome:

After learning the course the students should be able to

1. Understand basic terms used in thermodynamics.
2. Understand laws of thermodynamics and its applications.
3. Comprehend the concept and applications of energy, entropy and exergy.
4. Understand various gas and vapor power cycles.
5. Understand the properties of gas mixtures

List of Open Source Software/learning website: http://nptel.iitm.ac.in/courses.php

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

AUTOMOBILE ENGINEERING (02) /MECHANICAL ENGINEERING (19)

KINEMATICS OF MACHINES

SUBJECT CODE: 2131906

B.E. 3RD SEMESTER

Type of course: Engineering Science

Prerequisite: Zeal to learn the subject

Rationale: Kinematics of Machines is a fundamental course of mechanisms and machines. It is intended to introduceessential elements of machines and their functionality and engenders skills for kinematics analysis of machine elements like linkages, cams, and gears, within the general machine design context.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	1	0	4	70	20	10	30	0	20	150

Content:

Sr. No	Topic	Lectures	Weightage
1	**Introduction of Mechanisms and Machines:** Concepts ofKinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion, Four bar chain and Slider Crank Mechanisms and their Inversions, Degrees of Freedom,Mobility and range of movement - Kutzbach and Grubler's criterion, Number Synthesis, Grashof's criterion	**4**	**10%**
2	**Synthesis and Analysis of Mechanisms:** **Position analysis (Analytical Techniques)**: Loop closure (Vector Loop) representation of linkages, Position analysis of Four bar, slider crank and inverted slider crank mechanisms, Coupler curves, Toggle and Limit Position, Transmission angle, Mechanical Advantage. **Dimensional Synthesis**: Definitions of Type, Number and Dimensional Synthesis, Definitions ofMotion, Path and Function generation, precision position, Chebychev spacing, structural error, Freudenstein's equation, two and three position synthesis (function generation only) of four bar and slider crank mechanisms by graphical and analytical methods. **Velocity and Acceleration Analysis**: Velocity and Acceleration Diagrams, Instantaneous Centre of Velocity, Rubbing Velocity, Velocity and Acceleration Images, Corioli's component of acceleration. **Special Mechanisms**: Straight line mechanism, Indicator diagrams,	**4** **6** **6**	**40%**

	Hooke's Joint, Steering Mechanisms.	**3**	
3	**Gears and Gear Trains:** **Gears:**Terminology, Law of Gearing, Characteristics of involute and cycloidal action, Interference and undercutting, centre distance variation, minimum number of teeth, contact ratio, spur, helical, spiral bevel and worm gears, problems. **Gear Trains:** Synthesis of Simple, compound & reverted gear trains, Analysis of epicyclic gear trains.	**5** **5**	**25%**
4	**Cams and Followers:** **Introduction**: Classification of cams and followers, nomenclature, displacement diagrams of follower motion, kinematic coefficients of follower motion. **Synthesis and Analysis**: Determine of basic dimensions and synthesis of cam profilesusing graphical methods, cams with specified contours.	**3** **6**	**25%**

References:

1. Theory of Machines and Mechanisms (3/e 2009, 2013 Impression) Uicker J J Jr., Pennock G R, Shigley J E, Oxford Press.
2. Kinematics and Dynamics of Machinery (1/e 2009, 2013 Reprint) Norton R L, McGraw-Hill
3. Mechanism and Machine Theory (2013 Reprint), Ambekar, A G, Prentice Hall
4. Theory of Machines, Singh Sadhu, Pearson Education
5. Theory of Machines, Rattan S S, Tata McGraw-Hill

Web Resources

http://kmoddl.library.cornell.edu/

Course Outcomes:

1. Students will be able to identify functional characteristics various machine elements.
2. Students will demonstrate the ability to synthesize and analyse mechanisms.
3. Students will demonstrate ability to design and analyse cams.
4. Students will demonstrate the ability analyse gear trains.

Tutorials and Project Work:

1. Tutorials should be designed to cover contents of the theoretical portion.
2. In addition to tutorials assignments should be given to students for additional practice and demonstrate verities in a given topic.
3. Students should be given projects which may include development of computer codes of analytical methods, computer models and computer aided simulations, and development of functioning prototypeof various mechanisms.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.