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

NANO TECHNOLOGY (39)

FUNDAMENTALS OF SOLID STATE TECHNOLOGY

SUBJECT CODE: 2130401

B.E. 3RD SEMESTER

Type of course: Material Science and Technology

Prerequisite: Solid state physic, crystal physics, mathematics (differentiation and integration), material chemistry (inorganic chemistry) and some physical properties of materials from 12th science level syllabus.

Rationale: The purpose of this course is to develop comprehension of the rapidly changing technological scenario and the requisite expertise for appropriate selection of materials and its basic knowledge for specific engineering 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	0	3	70	20	10	0	0	0	100

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	CRYSTALPHYSICS: Periodic array of atoms, Translation vectors, Unit cell, Space lattice, Miller indices, Simple Crystal Structures, Bonds in solids. Nano Crystalline Solids, Physical properties of Nanomaterials, Melting points and Lattice Phonons	7	20
2	STRUCTURAL PROPERTIES: Defects in Solids, Mechanical properties X-ray diffraction methods and their applications in identification of crystal structures, Geometric factor reciprocal lattice.	6	20
3	LATTICE VIBRATIONS AND THERMAL PROPERTIES OF SOLIDS: Concept of lattice vibrations and thermal heat capacity, classical, Einstein and Debye theories of molar heat capacity and their limitations, Concept of phonons.	7	20
4	SOLID STATE SEMICONDUCTING MATERIAL: Intrinsic semiconductors, doping and extrinsic semiconductors, Simple models for semiconductors, Donor and acceptor levels, p-n junction and rectification, tunneling and resonant tunneling, Hall effect in semiconductors	7	20
5	DIELECTRIC AND MAGNETIC MATERIALS: Dielectric properties of solids, Magnetic materials and its	7	20

	properties. Ferrites & Nano-Magnets. Optical and thermal properties of semiconductors. Structures of Ceramics, Polymers &Composites.		

Reference Books:

1. Introduction to Solid State Physics C. Kittle
2. Solid State Physics:A.J. Decker
3. Solid State Physics: S.O. Pillai
4. Nanostructures and Nano materials Guozhong CaO, Imperial College Press, 2006
5. S.O. Kasap, "Principles of Electronic Materials and Devices", Tata McGraw Hill Edition, New Delhi, 2002.
6. Van Vlack, L.H., "Material Science for Engineers", 6th edition, .Addision Wesley, 1985.
7. Thiruvadigal, J. D., Ponnusamy, S. and Vasuhi.P. S., "Materials Science", 5th edition, Vibrant Publications, Chennai, 2007.
8. Rolf E. Hummel, "Electronic Properties of materials", Narosa Publishing House, New Delhi, 1994.
9. Raghavan.V., "Materials Science & Engineering – A First Course", 5th edition, Prentice Hall of India, NewDelhi,2005.
10. Khanna. O. P., "A Text Book of Material Science & Metallurgy", Revised edition, Dhanpat Rai Publications,New Delhi,2006.
11. Mick Wilson, Kamali Kannangara, Michells Simmons and Burkhard Raguse, "Nano Technology – Basic Science and Emerging Technologies", 1st edition, Overseas Press,New Delhi,2005.

Course Outcome:

At the end of the semester, the student will be able to:

1. Understand crystal and physical properties of materials,
2. Understand the properties and applications of semi conducting materials,
3. Understand general properties and applications of magnetic and dielectric materials,
4. Understand general properties and application Ferrites & Nano-Magnets.
5. Understand Optical and thermal properties of semiconductors

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

NANO TECHNOLOGY (39)

ELEMENTS OF NANOSCIENCE AND NANOTECHNOLOGY-I

SUBJECT CODE: 2130402

B.E. 3RD SEMESTER

Type of course: Nanoscience and Nanotechnology

Prerequisite: To understand above subject knowledge of optical physics, inorganic chemistry, crystal structure of materials (Crystal Physics), and electrical and magnetic properties of materials syllabus up to 12th Science level are required.

Rationale: The objective of this course is to make students familiar with the important concepts in Nanotechnology.

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	0	3	70	20	10	0	0	0	100

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	NANOTECHNOLOGY: Background, what is nanotechnology, types of nanotechnology and nano-machines, top down and bottom up techniques, Molecular nanotechnology, atomic manipulation-nanodots, self-assembly, Dip pen nanolithography, Simple details of characterization tools-SEM, TEM, STM,AFM.	5	15
2	NANOMATERIALS : What are Nanomaterials? Preparation of Nanomaterials-Plasma arcing, Chemical Vapor Deposition, Sol-gels techniques, ElectrodepositioN, Ball Milling, Natural Nanomaterials, Applications of Nanomaterials-Insulation materials, Machine tools, Phosphors, Batteries, High power magnets Medical implants.	7	20
3	NEW FORMS OF CARBON: Carbon tubes-types of nanotubes, formation of nanotubes, Assemblies, purification of Carbon nanotubes, Properties of nanotubes, applications of nanotubes.	6	15
4	OPTICS, PHOTONICS AND SOLAR ENERGY: Light and nanotechnology, Interaction of light and nanotechnology, Nanoholes and photons, Solar cells, Nanoparticles and nanostructures; Optically useful nanostructured polymers, Photonic Crystals.	6	15
5	NANOELECTRONICS: Introduction, Tools of Micro- and Nanofabrication-optical and electron beam lithography, Molecular beam	6	15

	lithography, Quantum electronic devices, Molecular electronics, Simple ideas about quantum computers.		
6	APPLICATIONS : MEMs, robots, Nanomachines, Nanodevices, New Computing System, Optic-electronic devices, Environmental applications, Nanomedicine, Biological Nano-Technological future.	10	20

Reference Books:

1. Nanotechnology-Basic Science and Emerging Technologies Mick Wilson, Kamali Kannangra Geoff Smith, Michelle Simons and Burkhard Raguse, Overseas Press.
2. Nanotechnology-AGentle Introduction to the Next Big Idea Mark Ratner and Daniel Ratner, Prentice Hall
3. Nanotechnology: RebeccaLJohnson, Lerner Publications.
4. Introduction to Nanotechnogy: Charles P. Poole Jr., Chapman and Hall/CR
5. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002
6. A.Nabok, "Organic and Inorganic Nanostructures", Artech House, 2005
7. C.Dupas, P.Houdy, M.Lahmani, Nanoscience: "Nanotechnologies and Nanophysics", Springer-Verlag Berlin Heidelberg, 2007

Course Outcome:

- Get knowledge of Nanotechnology
- Understand difference between properties Nanomaterial and conversional materials
- Understand the application of Nanomaterials
- Understand the mean of Nanoelectronics
- Understand the optical properties of Nanomaterials.

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

NANO TECHNOLOGY (39)

SYNTHESIS OF NANOMATERIALS-I

SUBJECT CODE: 2130403

B.E. 3RD SEMESTER

Type of course: Nanoscience and Nanotechnology

Prerequisite: For understand mention subject require basic knowledge of inorganic chemistry, physics of materials, and solid state chemistry up to 12th science level.

Rationale: To introduce the students to the basics concept of the synthesis of different Nanomaterials using various synthesis techniques

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		
2	0	4	6	70	20	10	20	10	20	150

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	INTRODUCTION: Classification of Nanostructures, Nano - Scale Architectures Effects of nanometer length scale on Physical and Chemical Properties of Materials	6	20
2	FABRICATION METHODS:- Top down processes, Bottom-up processes, Methods for tinplating the growth of Nano-materials; Ordering of Nano-systems; Preparation, safety and storage issues	6	20
3	SOLID STATE RECACTIONS: Reactions between solid compounds Solid-Gas Reactions Decomposition and Dehydration Reactions Intercalation Reactions	6	20
4	FORMATION OF SOLIDS FROM THE GAS PHASE: Chemical Vapor Transport, Chemical Vapor Deposition (1)Metal CVD (2)Diamond CVD (3)CVD of Metal Oxide and semiconducting compound (4)CVD of Metal Nitrides Aerosol Processes Formation of Solids from Solutions and Melts Porous Materials.	8	20
5	NANOSTRUCTURE MATERIALS: Nano Particles and Nanocrystalline Materials 1)Nanocrystalline Ceramics 2)Semiconductor Nanoparticles 3)Metal Nanoparticles 4)Nanotubes	7	20

	5)Mono and Multilayer		

Reference Books:

1. Synthesis of Inorganic Materials , Ulrich Schubert, Nicola Husing (2nd Edition WILE/VCH)
2. Nano scale Science and Technology Robert Kelsall, Ian Hamley, and Mark Geoghegan (Editors) John-Wiley
3. Nanomaterials: Synthesis, Properties and Applications A.S.Edelstein and R.C.Cammarata (edits), Institute of Physics
4. Nanostructures and Nano materials-Synthesis, Properties and Applications (Cao, Imperial College Press)
5. Charles P.Poole Jr. "*Introduction to Nanotechnology*", John Willey & Sons , 2003. T. Pradeep , "*NANO The Essential , understanding Nanoscience and Nanotechnology".* Tata McGraw-Hill
6. Publishing Company Limited , 2007. Joel I. Gersten, "The Physics and Chemistry of Materials", Wiley, 2001.
7. A. S. Edelstein and R. C. Cammarata, "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Pub., 1998.
8. K.W. Kolasinski, "Surface Science: Foundations of Catalysis and Nanoscience", Wiley, 2002.
9. S.Yang and P.Shen: "Physics and Chemistry of Nanostructured Materials",Taylor & Francis, 2000.
10. G.A. Ozin and A.C. Arsenault, "Nanochemistry : A chemical approach to nanomaterials", Royal Society of Chemistry, 2005.

Course Outcome:

At the end of the semester, the student will be able to:

1. Understand solid state reaction
2. Understand different Nano - Fabrication methods
3. Lean about interesting effects take place at the Nanoscale
4. Be able to list a range of industries where Nanotechnology is applied

List of Experiments:

Sr. No	Topics
1.	Introduction of Nano synthesis The objective of this course is to make the students familiar with the different methods of synthesis for Nanomaterials.
2.	Synthesis of conducting glass using TiO2 Nanoparticles
3.	Synthesis of Solar cell using TiO2 Nanoparticles
4.	I-V Measurements of Nanomaterials solar cell with different particle size
5.	Synthesis of silver Nanoparticles
6.	Synthesis of nanocrystalline ceramics
7.	Understanding of manipulating matter at atomic level using Ni-Ti alloy demonstration
8.	Understanding of Nanoparticles of a magnetic material are dispersed in a liquid (Nano ferrofluids) using Ferro Fluid Demonstrator Comparison of bulk and Nano iron particles.

9.	Fundamental aspects of VLS and SLS growth – VLS growth of Nanowires – Control of the size of the Nanowires – SLS growth – Stress induced recrystalization.

Open ended/design based Projects on Science and technology :-

Open Ended /design based project: Apart from above experiments a group of students (Maximum Three) has to undertake one open ended problem/design problem. **(Students are free to select any area of science and technology may be based on their branch to define the project)**

Aims:
1. To provide experience in laboratory based experimentation, data recording and analysis and drawing of conclusions.
2. To develop report writing skills for scientific material
3. To develop the ability to undertake investigations where, as part of the exercise, the goals and methods have to be defined by the investigator.
4. To develop skills in literature searches and reviews.

Evaluation of Open ended / design based small project

1. Open ended / design based small project will be evaluated by external examiner with appropriate marks allotment given by GTU time to time.
2. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
3. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.

Examples:
1. To develop a visual understating of surface area, as items are made smaller and smaller
2. Synthesis of Nanomaterial using locally products and chemicals.
3. Fabrication of solar cell or p-n junction diode using Nanomaterials

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

NANO TECHNOLOGY (39)

CHARACTERIZATION OF NANOMATERIALS-I

SUBJECT CODE: 2130403

B.E. 3RD SEMESTER

Type of course: Instrumentation in Nanoscience and Nanotechnology

Prerequisite: Require basic knowledge of computer operation and computer language which helps student to understand characterisation of Nanomaterials using different instrumental software, Solid State Physics and basic knowledge of Nanomaterials are also require to understand basic properties of Nanomaterials.

Rationale: The objective of this course is to make students familiar with different characterization techniques which are useful indentifying physical, optical and biological properties of Nanomaterials

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	OEP		
2	0	4	6	70	20	10	20	10	20	150

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	INTRODUCTION: Optical microscopes, Electron microscopes and Scanning probe microscopes, The general application of SEM, TEM & Spectroscopy.	4	10
2	Scanning Electron Microscopy (Sem),	4	15
3	Transmission Electron Microscopy (Tem)	4	15
4	Advanced Optical Microscopy (Aom),	4	15
5	X-Ray Diffraction	5	15
6	Optical Thin Film Measurements, Ellipsometry, Profilometry, Resistively/Conductivity Measurements.	6	15
7	Breakdown Measurements, Junction Testing, Capacitance-Voltage & Current Voltage Measurements.	6	15

Reference Books:

1. Encyclopedia of Materials Characterization Tools/Equipment, Brundle, Evans, Jr.Watson, Manning Publishing, 1992.
2. Willard, Merritt, Dean, Settle, " Instrumental Methods of Analysis ", CBS publishers & Distributors, Delhi, Sixth Edition, 1986.
3. Colin N. Banwell and Elaine M. McCash, Molecular Spectroscopy, Mcgraw-Hill College; 4 Sub edition (June
4. 1, 1994), ISBN-10: 0077079760

5. Rainer Waser (Ed.) , "Nano electronics and information technology", Wiley- VCH., Edition II, 2005.
6. Willard, Merritt, Dean & Settle, Instrumental Methods of Analysis, Wadsworth Publishing Company; 7 Sub edition (February 1988), ISBN-10: 0534081428.
7. P. J. Goodhew and F. J. Humphreys. Electron Microscopy and Analysis, 2rd Ed. Taylor and Francis, 1988.

Course Outcome:

- Get introduction of different and complicate techniques to characterized properties of Nanomaterials.

List of Experiments:

Sr. No.	Topics
1.	Introduction of Analysis and characterization of nanostructured Materials ,Coating and Thin Film Sensors
2.	Powder X-Ray Diffraction - XRD : Structure Identification
3.	Powder X-Ray Diffraction - XRD: Composition and Phase Identification, Particle size calculation,
4.	Atomic Force Microscopy - AFM Light Microscopy Fluorescence: Surface analysis
5.	AFM Microscopy: 2D and 3D View, Roughness and Porosity analysis
6.	Surface Tension Measurements of Nanofluids
7.	Transmission Electron Microscopy – TEM (Data analysis)
8	To observe the size and shape of the nanosized sample using SEM

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Examples
1. Chaterization of any one material from local Industries.
2. A survey of Materials used in local industries and focus on the nature of microstructure and its manipulation and control to determine engineering properties.

3.Report on learning of Simulation software any characterization technique.

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.