STRENGTH OF MATERIALS

ENCE 151

Lecture : 3 **Year : I**
Tutorial : 1 **Part : II**
Practical : 2/2

Course Objectives:

The primary goal of the course is to build the fundamental understanding of students on geometric properties of sections, material behavior, stress-strain relations, flexure, torsion, buckling and failure types in the structural elements due to external loads and temperature variations. After completing this course, students should be able to develop competency on material behavior and their analysis due to external loadings and temperature change, evaluate geometric properties of complex geometric figures and analyze structural members under flexure, shear, torsion and buckling.

1 Simple Stress and Strain (10 hours)

1.1 Introduction to strength of materials
1.2 Deformable bodies, external forces, internal stresses and strains
1.3 Types of stresses: Normal stress, shear stress, bearing stress
1.4 Material behavior under axial loading: Stress-strain diagram for mild steel, yield stress, proportional limit, elastic limit, Hooke's law, Young's modulus of elasticity, strain hardening, ultimate stress/strength, ductility, toughness, elastic and inelastic strains, concept of factor of safety and allowable/permissible stress
1.5 Stress-strain behavior for ductile and brittle materials, proof stress
1.6 Fatigue and creep strength
1.7 Thermal stress and strain in simple, compound, composite and indeterminate bars
1.8 Lateral strains and Poisson's ratio
1.9 Shear deformation and shear angle; Hooke's law for shearing deformations, modulus of rigidity
1.10 Multi-axial loading and generalized Hooke's law
1.11 Definitions of isotropic, anisotropic and orthotropic materials
1.12 Volumetric stress-strain, bulk modulus
1.13 Relationships between elastic constants
1.14 Saint-Venant's principle and stress concentrations
1.15 Elongation of bars under axial loadings: Uniform and varying cross-sections, tapered sections, compound and composite bars
1.16 Use of compatibility equations for axially loaded indeterminate bars

2 Geometric Properties of Sections (5 hours)

2.1 Axes of symmetry
2.2 Centre of gravity of plane and built-up sections
2.3 Moment of inertia of standard and built-up sections
2.4 Parallel and perpendicular axis theorems
2.5 Polar moment of inertia
2.6 Radius of gyration
2.7 Product moment of inertia
2.8 Principal axes and principal moment of inertia
2.9 Mohr's circle for principle moment of inertia

3 Principal Stress Analysis in 2D Planes (5 hours)

3.1 Stresses in inclined plane: Normal stress under uniaxial loading, Normal and shear stress subjected to two mutually perpendicular planes
3.2 Principal planes and principal stresses
3.3 Relationships between normal and shear stresses
3.4 Maximum shear stresses
3.5 Mohr's circle diagram for principal stresses

4 Principal Strain Analysis (4 hours)

4.1 Plane strain: Normal and shear strains in inclined planes
4.2 Principal strains, maximum in-plane shear strains and their positions
4.3 Mohr's circle diagram for plane strain
4.4 Absolute maximum shear strain
4.5 Strain rosettes
4.6 Modes of failure for different materials
4.7 Introduction of failure theories

5 Thin Walled Vessels (3 hours)

5.1 Introduction and characteristics
5.2 Types of stresses and strains in cylindrical and spherical pressure vessels
5.3 Calculation of stresses and strains in pressure vessels

6 Torsion (5 hours)

6.1 Introduction to torsion
6.2 Stress-strain behavior in torsion
6.3 Derivation of torsion formula for a circular shaft
6.4 Torsional moments: Series and parallel combination of shafts and composite shaft
6.5 Torsional stress in shafts, torsional resilience
6.6 Comparison between solid and hollow shafts
6.7 Power transmitted by shafts

6.8 Statically indeterminate shafts
6.9 Introduction to non-circular shafts
6.10 Combined bending and torsion

7 Theory of Flexure (8 hours)

7.1 Introduction to flexure
7.2 Coplanar and pure bending
7.3 Derivation of bending equation
7.4 Distribution of bending stress across the different beam cross-sections
7.5 Analysis of beams for symmetric and composite sections
7.6 Shear equation, shear stress variation in rectangular, circular, I and T sections
7.7 Concept of slope and deflection in beams using double integration method: Simply supported and cantilever beams

8 Column Theory (5 hours)

8.1 Introduction: Buckling and stability of columns
8.2 Classification based on slenderness ratio
8.3 Effect of support conditions and effective length
8.4 Derivation of Euler's formula for different end conditions, limitations and applicability
8.5 Intermediate columns: Rankine's hypothesis
8.6 Introduction to uniaxial and biaxial eccentric loading, condition for no tension

Tutorial (15 hours)

1. Problems on stresses and strains on regular and irregular structural members due to external forces, self-weight and temperature change
2. Problems on geometrical properties of 2-D sections
3. Problems on principal stresses
4. Problems on principal strains
5. Problems on thin walled vessels
6. Problems on circular shafts due to torsion
7. Problems on flexure and deformation of beams
8. Problems on columns and compound stresses

Practical (15 hours)

1. Tensile test and stress-stress curve for mild steel bar, HYSD bar, timber
2. CG of simple plane figure
3. Simple bending test on timber, steel, aluminum beams: Deflection, flexural relations and MoI comparisons
4. Torsion test on simple shaft to determine modulus of rigidity
5. Test on column behavior and buckling

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	10	13
2	5	7
3	5	7
4	4	5
5	3	4
6	5	7
7	8	10
8	5	7
Total	**45**	**60**

* There may be minor deviation in marks distribution.

Reference

1. Beer, F.P., Johnston, E.R. (2015). Mechanics of materials. Tata McGraw Hill.
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3. Rajput, R. K. (2018). A textbook of strength of materials. S. Chand and Company.
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5. Popov, E.P. (1978). Mechanics of materials (Latest Edition). Prentice Hall.
6. Pytel, A., Singer, F.L. (1998). Strength of materials (Latest Edition). Harper Collins.
7. Hibbeler, R.C. (2004). Statics and mechanics of materials. Prentice Hall.
8. Motra, G.B. (2021). A textbook of strength of materials. Heritage Publishers & Distributors.

ENGINEERING GEOLOGY II

ENCE 152

Lecture : 2 **Year : I**
Tutorial : 0 **Part : II**
Practical : 2/2

Course Objectives:
The course will provide the fundamental knowledge of engineering geology to the civil engineering students. Students will be able to measure the geological data from the field, analyze and interpret them for the development of civil infrastructures, for their stability and to provide input design parameters.

1 Hydrogeology (2 hours)

1.1 Basic terminologies: Porosity, permeability, hydraulic conductivity, deep and shallow groundwater circulation
1.2 Introduction of aquifer and ground water movement
1.3 Different aquifer system, artificial recharge and springshed management in the Nepal Himalaya

2 Rock Properties and Laboratory Tests (4 hours)

2.1 Definition and importance of rock properties in engineering
2.2 Mechanical properties of rocks: Stress-strain behavior, elastic modulus, Poisson's ratio and strength
2.3 Generalized Hoek-Brown failure criterion
2.4 Introduction to laboratory testing: Uniaxial compression test, Brazilian tensile strength test, Triaxial compression test, Point load test, Schmidt hammer test, Direct shear test, Slake durability test
2.5 Introduction to In-Situ stress test: Flat-Jack, Bore-hole over coring method, Hydrofracturing

3 Rock Mass Classification (4 hours)

3.1 Introduction to rock mass
3.2 Discontinuity characters
3.3 Rock mass classification systems and their importance in civil engineering
3.4 Rock Mass Rating (RMR), NGI-Q system, and geological strength index (GSI)

4 Geological Hazards (6 hours)

4.1 Definition; Hazard, Vulnerability and Risk

4.2 Introduction of major geological hazards and their effect on development of earth surfaces
4.3 Landslides: Definition, classification, causes and mitigative measures
4.4 Earthquakes and seismicity: Definition, measurement, causes and effects
4.5 Erosion, flood, landslide dam outburst flood (LDOF) and glacial lake outburst flood (GLOF)

5 Engineering Geology for Site Selection and Construction (10 hours)

5.1 Aims and methods of engineering geological site investigation
5.2 Study of topographic, geological, and engineering geological maps, satellite imagery, and Synthetic-Aperture Radar (SAR) image
5.3 Introduction to geophysical investigation: Electrical Resistivity Tomography (ERT), Seismic Refraction Tomography (SRT), Multichannel Analysis of Surface Waves (MASW), Microtremor Array Measurement (MAM)
5.4 Geological investigation for dam, reservoir, road, canal, bridges, and underground excavation
5.5 Introduction of borehole, core drilling, core logging, sampling, and bore hole problems
5.6 Tunneling in rock: Methods, geological considerations, and tunnel mapping

6 Rock Slope Engineering (4 hours)

6.1 Stereographic projection: Plotting a line and planes, representative joint set, rosette diagram
6.2 Kinematic analysis of rock slope and modes of failure (Plane, wedge, toppling)
6.3 Rock slope stabilization measures

Practical (15 hours)

1. Study of engineering geological maps: Preparation and interpretation
2. Study of relationship between true dip and apparent dip
3. Study of borehole problems and calculation of bedrock thickness
4. Study and analysis of discontinuities data for failure mechanism by stereographic projection
5. Study of mineral distribution in sand using binocular microscope
6. Presentation of geological data using joint rosette diagram
7. Interpretation of geophysical investigation data

Field Works (2 days)

A two-days fieldwork to provide practical on-site knowledge of engineering geology in any one of the road/highway projects under construction or have severe geo-hazard problem/any one of the hydropower projects under construction. Students submit report after the fieldwork (**Attendance in Fieldwork is Compulsory**).

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	2	2
2	4	4
3	4	4
4	6	6
5	10	10
6	4	4
Total	**30**	**30**

* There may be minor deviation in marks distribution.

Reference

1. Evert, H. (2006). Practical Rock Engineering. (Reissued edition) RocScience / University of Toronto.
2. Nilsen, B., Palmstrom, A. (2000). Engineering Geology and Rock Engineering. Norwegian Group of Rock Mechanics (NBG).
3. Price, D. (2009). Engineering Geology: Principles and Practice (M. H. de Freitas, Ed.). Springer.
4. Hoek, E., Brown, E.T. (2019). The Hoek-Brown failure criterion and GSI-2018 edition. Journal of Rock Mechanics and Geotechnical Engineering.
5. Vallejo, L.G. de, Ferrer, M. (2011). Geological Engineering. Routledge, Taylor & Francis Group.
6. Todd, D.K., Mays, L.W. (2005). Groundwater Hydrology. John Wiley & Sons.
7. Krynine, D., Judd, W. R. (2005). Principles of Engineering Geology and Geotechnics. CBS Publishers.
8. Deoja, B., Dhital, M., Wagner, A., Thapa, K.B. (1991). Mountain Risk Engineering Handbooks I & II. ICIMOD.
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ENGINEERING SURVEY I

ENCE 153

Lecture : 3 **Year : I**
Tutorial : 1 **Part : II**
Practical : 4

Course Objectives:
The objective of this course is to introduce student to the fundamentals of surveying which is basic to all civil engineering projects. In this course, specific emphasis will be given to plane surveying. This course provides basic knowledge of land measurement and surveying techniques to civil engineering students, and make them to learn and understand the theory and field procedures by applying suitable surveying methods to produce map.

1 Introduction (3 hours)

1.1 Definition of surveying
1.2 History of surveying
1.3 Principle of surveying
1.4 Classification of surveying

2 Distance Measurements (6 hours)

2.1 Units and methods of linear measurements
2.2 Significant figures and rounding of numbers
2.3 Accessories for linear measurements
2.4 Method of distance measurement on fairly level and sloping ground
2.5 Types and sources of error, accuracy and precision
2.6 Scales and its classification, plotting accuracy and factors selecting scale

3 Basic Surveying Techniques (3 hours)

3.1 Introduction to chain surveying
3.2 Principles, offsets and field booking of chain/offset surveying
3.3 Principle, accessories and method of plane table surveying
3.4 Advantages and disadvantages of plane table surveying

4 Compass Surveying (5 hours)

4.1 Introduction
4.2 Direction of line and meridian
4.3 Bearing and types of bearing
4.4 Calculation of angle and bearing
4.5 Local attraction

4.6 Compass traversing and calculation
4.7 Plotting and graphical adjustment
4.8 Sources of errors

5 Levelling (10 hours)

5.1 Terms and definitions and importance of levelling
5.2 Principle of levelling
5.3 Types / methods of levelling
5.4 Equipment of levelling
5.5 Temporary and permanent adjustment of level
5.6 Two peg test
5.7 Booking and calculation of reduced level
5.8 Classification of levelling and criteria for different levelling
5.9 Reciprocal levelling and precise levelling
5.10 Calculation of fly levelling, loop levelling and adjustment
5.11 Refraction and curvature correction
5.12 Sources of errors in levelling

6 Modern Surveying Techniques (7 hours)

6.1 Theodolite
- 6.1.1 Basic definitions
- 6.1.2 Construction principles and parts of theodolite
- 6.1.3 Temporary adjustment of theodolite
- 6.1.4 Measurement of horizontal and vertical angles by direction and repetition method
- 6.1.5 Errors in theodolite and field instructions

6.2 Electronic Distance Measurement (EDM)
- 6.2.1 Classification of EDM
- 6.2.2 Working principles of EDM
- 6.2.3 Errors in EDM

6.3 Total Station
- 6.3.1 Introduction and features
- 6.3.2 Electronic data recording procedures
- 6.3.3 Uses of total station and field procedures

7 Triangulation and Trilateration (3 hours)

7.1 Principles of triangulation and trilateration
7.2 Classification of triangulation and trilateration system
7.3 Instruction to field application

8 Tacheometry (5 hours)

8.1 Introduction, uses and importance

8.2 Principle of optical distance measurement
8.3 System of tacheometry: stadia; tangential for vertical staff and horizontal subtense bar
8.4 Field problems and instructions

9 Plotting and Mapping (3 hours)

9.1 Plotting of map, L-section, Cross section
9.2 Plotting and mapping software
9.3 Comparison of manual plotting and computerized plotting

Tutorial (15 hours)

1. Distance measurements (Construction of diagonal scale and problem related to shrunk scale)
2. Compass surveying (Calculation of bearing to angle and angle to bearing; computation and correction of bearing for close loop close traverse and link traverse for different cases)
3. Levelling (Calculation of field book by HI and Rise fall method; problems on missing data; two peg and reciprocal levelling; fly level, profile level and loop levelling problems)
4. Modern surveying techniques (Calculation of horizontal and vertical angles for different set of angles)
5. Tacheometry (Calculation of different problems related to stadia, tangential and subtense bar method for the staff vertical case only)

Assignment

1. Tutorials provided in respective chapters
2. Digital data recording plotting by software

Practical (60 hours)

1. Horizontal, vertical and slope distance measurement on fairly level and sloping ground by using tape and Abney level
2. Compass traversing and detailing by compass and offset method
3. Two peg test and fly levelling
4. Profile and cross section levelling
5. Measurement of horizontal and vertical angles by directional method
6. Two set horizontal angle measurement of polygon by total station by manual recording
7. Digital data recording by total station for the close traverse and plotting

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	3	4
2	6	8
3	3	4
4	5	8
5	10	12
6	7	10
7	3	4
8	5	6
9	3	4
Total	**45**	**60**

* There may be minor deviation in marks distribution.

Reference

1. Bannister, A., Raymond S., Baker R. (1998). Surveying (Latest Edition). Pearson.
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4. Basak, N.N. (2004). Surveying and Levelling. Tata McGraw-Hill Education.
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ENGINEERING DRAWING

ENME 158

Lecture : 2 **Year : I**
Tutorial : 0 **Part : II**
Practical : 4

Course Objectives:

To develop basic projection concepts with reference to points, lines, planes and geometrical solids. Also, to develop sketching and drafting skills to facilitate communication.

1 Instrumental Drawing, Technical Lettering Practices and Techniques (1 hour)

1.1 Equipment, materials and drawing sheets
1.2 Description of drawing instruments, auxiliary equipment and drawing materials
1.3 Techniques of instrumental drawing
1.4 Pencil sharpening, securing paper, proper use of T- squares, triangles, scales dividers, compasses, erasing shields, French curves, inking pens
1.5 Line: Types and uses, thickness

2 Dimensioning (1 hour)

2.1 Fundamentals and techniques
2.2 Size and location dimensioning, SI conversions
2.3 Scales: Types and representative factor
2.4 Use of scales, measurement units, reducing and enlarging drawings
2.5 Placement of dimensions: Aligned and unidirectional, chain, parallel/baseline and combined type
2.6 Tolerance dimensioning

3 Geometrical Construction (2 hours)

3.1 Plane geometrical construction: Proportional division of lines, trisection of angles, smooth arc and line tangents
3.2 Methods for drawing regular polygons and standard curves such as ellipses, parabolas, hyperbolas, involutes, spirals, cycloids and helices (Cylindrical and conical), ogee curve
3.3 Techniques to reproduce a given drawing (By construction)

4 Basic Descriptive Geometry (4 hours)

4.1 Introduction to orthographic projection, principal planes, four quadrants or angles
4.2 Projection of points on first, second, third and fourth quadrants
4.3 Projection of lines: Parallel to one of the principal planes, inclined to one of the principal plane and parallel to other, Inclined to both principal planes, traces of a line
4.4 Projection planes: Perpendicular to both principal planes, parallel to one of the principal planes and Inclined to one of the principal planes, perpendicular to other and Inclined to both principal planes
4.5 True length of lines: Horizontal, inclined and oblique lines
4.6 Rules for parallel and perpendicular lines
4.7 Point view or end view of a line
4.8 Shortest distance from a point to a line
4.9 Edge view and true shape of an oblique plane
4.10 Angle between two intersecting lines
4.11 Intersection of a line and a plane, visible portion of line
4.12 Angle between a line and a plane
4.13 Dihedral angle between two planes
4.14 Shortest distance between two skew lines
4.15 Angle between two non-intersecting (Skew) lines

5 Multi View (Orthographic) Projections (8 hours)

5.1 Orthographic projections
- 5.1.1 First and third angle projection
- 5.1.2 Principal views: Methods for obtaining orthographic views, projection of lines, angles and plane surfaces, analysis in three views, projection of curved lines and surfaces, object orientation and selection of views for best representation, full and hidden lines
- 5.1.3 Orthographic drawings: Making an orthographic drawing, visualizing objects (Pictorial view) from the given views
- 5.1.4 Interpretation of adjacent areas, true-length lines, representation of holes, conventional practices

5.2 Sectional views: Full, half, offset, broken (Partial), rotated/aligned, revolved, removed (Detail) sections, phantom of hidden section, specifying cutting planes for sections, convention practices
5.3 Auxiliary views: Basic concept and use, drawing methods and types, symmetrical and unilateral auxiliary views, auxiliary sectional views

6 Developments and Intersections (7 hours)

6.1 Introduction and projection of solids with points transfer
6.2 Developments: General concepts and practical considerations, triangulation method for approximate development of surfaces of a right/oblique; Prism, cylinder, pyramid, cone, prism and cylinder cut by oblique planes,

frustum/truncated pyramid and cone, transition pieces for connecting different shapes and sphere

6.3 Intersections: Lines of intersection of geometric surfaces, piercing point of a line and a geometric solid, intersection lines of two planes, intersections of – prism and prism, cylinder and prism, cylinder and cylinder, pyramid and prism, cone and prism, pyramid and cylinder, cone and cylinder

7 Pictorial Drawings (7 hours)

7.1 Classifications: Advantages and disadvantages

7.2 Isometric view

- 7.2.1 Axonometric projection
- 7.2.2 Isometric projection and isometric drawing (View)
- 7.2.3 Isometric and non-isometric lines; Isometric and non-isometric surfaces
- 7.2.4 Angles in isometric drawing
- 7.2.5 Circles and circular arcs in isometric and non-isometric surfaces (Slopes)
- 7.2.6 Irregular curves in isometric drawing
- 7.2.7 Isometric sectional views

7.3 Oblique drawing

- 7.3.1 Procedure for making an oblique drawing
- 7.3.2 Rules for placing objects in oblique drawing
- 7.3.3 Angles, circles and circular arcs in oblique drawing

7.4 Perspective projection

- 7.4.1 Terms used in perspective projection
- 7.4.2 Parallel and angular perspective
- 7.4.3 Selection of station point
- 7.4.4 Perspective projection of right prism and pyramid solid

Assignments

1. Geometrical construction
2. Descriptive geometry
3. Multi-view Projection I
4. Multi-view Projection II
5. Surface development and intersection
6. Isometric drawing
7. Oblique drawing and perspective projection

Practical (60 hours)

1. Drawing sheet layout, freehand lettering, scale, common graphical symbols, sketching of parallel lines, circles, dimensioning
2. Geometrical construction (Sketch and instrumental drawing)
3. Descriptive geometry I (Sketch and instrumental drawing)
4. Descriptive geometry II (Sketch and instrumental drawing)
5. Multiview drawings I (Sketch and instrumental drawing)

6. Multiview drawings II (Sketch and instrumental drawing)
7. Multiview, sectional drawings and dimensioning (Sketch and instrumental drawing)
8. Auxiliary view, sectional drawings and dimensioning (Sketch and instrumental drawing)
9. Projection of regular geometrical solids with point transfer (Sketch and instrumental drawing)
10. Surface development of solids I (Sketch and instrumental drawing)
11. Surface development of solids II (Sketch and instrumental drawing)
12. Intersection of solids (Sketch and instrumental drawing)
13. Isometric drawing I (Sketch and instrumental drawing)
14. Isometric drawing II (Sketch and instrumental drawing)
15. Oblique drawing and perspective projection (Sketch and instrumental drawing)

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks Distribution *
1, 2 and 3	4	3
4	4	3
5	8	9
6	7	8
7	7	7
Total	**30**	**30**

* There may be minor deviation in marks distribution.

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1. Luzadder, W.J., Duff, J.M. (1989). Fundamentals of engineering drawing: With an introduction to interactive computer graphics for design and production (Latest Edition). Prentice-Hall.
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7. Luintel, M.C. (2021). Engineering Drawing I. Heritage Publishers & Distributors.
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ENGINEERING MATHEMATICS II

ENSH 151

Lecture : 3 **Year : I**
Tutorial : 2 **Part : II**
Practical : 0

Course Objectives:
After completion of the course students will be able to apply knowledge of partial differentiation, multiple integrals, vector calculus, optimization, matrices and infinite series in their corresponding study area.

1 Calculus of Two and More Variables (6 hours)

1.1 Partial differentiation
- 1.1.1 Partial derivatives of first and higher order
- 1.1.2 Homogeneous function: Euler's theorem for two and three variables
- 1.1.3 Total derivatives and differentials, differentiation of composite and implicit functions
- 1.1.4 Jacobians and their properties

1.2 Extreme values of two and three variables. Lagrange's multiplier

1.3 Application in optimization of function of two variables in one constraint

2 Multiple Integrals (7 hours)

2.1 Double integrals in Cartesian and Polar form, change of order of integration

2.2 Triple integrals in Cartesian, cylindrical and spherical coordinates

2.3 Area, volume, moment of inertia, mass and centroid by double and triple integrals

3 Vector Calculus (12 hours)

3.1 Review of scalar and vector products, scalar and vector triple product, scalar and vector product of four vectors

3.2 Vector differentiation and integration, their geometrical meaning, velocity and acceleration

3.3 Vector differential operators: Gradient, directional derivatives, divergence and curl

3.4 Line integrals, independent of path, conservative and irrotational vector fields, scalar potential

3.5 Introduction to Green's theorem and its application

3.6 Surface integrals, calculation of flux

3.7 Volume integrals, Gauss divergence theorem (Without proof) and its application in evaluation of surface integrals
3.8 Introduction to Stoke's theorem and its application

4 Laplace Transform (7 hours)

4.1 Definition of Laplace transform, condition for existence, Laplace transforms of some elementary functions, properties of Laplace transform, shifting and change of scale properties
4.2 Inverse Laplace transform, uniqueness of inverse Laplace transform, properties of inverse Laplace transform
4.3 Laplace transform of derivatives and integral, multiplication and division by t^n the convolution theorem
4.4 Laplace transform of Heaviside's unit function, Dirac-delta function and periodic functions
4.5 Application of Laplace transform to ordinary differential equations

5 Matrices (8 hours)

5.1 Review of algebra of real and complex matrices
5.2 Rank of matrices and its application in system of linear equations
5.3 Vector space, linear dependence and independence
5.4 Eigen values: Cayley Hamilton theorem and its applications
5.5 Eigen vectors, diagonalization of matrices
5.6 Reduction of quadratic forms into canonical forms (Three variables only)

6 Solution of Differential Equation in Series and Special Functions (5 hours)

6.1 Power series method
6.2 Bessel's functions: Introduction, properties and application
6.3 Legendre's function: Introduction, properties and application

Tutorial (30 hours)

1. Techniques of partial differentiation, differentiation of composite and implicit functions, total derivatives, and related exercises
2. Exercises related to Euler's theorem
3. Exercises related to extreme values of two and three variables
4. Change of order of integration in multiple integrals
5. Exercises related to application of double and triple integrals in finding area, volume, moment of inertia, mass and centroid
6. Examples related to revision of scalar and vector product of two and three vectors
7. Problems on gradient, directional derivatives, divergence and curl
8. Exercises on line integrals, independent of path
9. Exercises on surface integrals
10. Exercises on Green's theorem, verification and application in calculating line integrals
11. Verification of Stoke's theorem, application

12. Verification of Gauss' Divergence theorem, and application in calculating surface integrals
13. Exercises related to Laplace transforms
14. Exercises on inverse Laplace transforms
15. Problems related to application of Laplace transform to ordinary differential equations
16. Examples related to Laplace transform of Heaviside's unit function, Dirac-delta function and periodic functions
17. Rank and solution of simultaneous equations
18. Eigen values and Eigen vectors, diagonalization problems
19. Problems related to reduction of quadratic forms into canonical forms
20. Exercises related to Bessel's function and Legendre's polynomial

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	6	8
2	7	8
3	12	18
4	7	8
5	8	12
6	5	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Kreyszig, E. (2011). Advanced engineering mathematics. John Wiley & Sons.
2. Jeffrey, A. (2002). Advanced engineering mathematics. Academic Press.
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ENGINEERING PHYSICS

ENSH 152

Lecture : 4 **Year : I**
Tutorial : 1 **Part : II**
Practical : 2

Course Objectives:
To provide students a concept and sound knowledge of physics with the emphasis in present day applications to apply them in relevant fields. The background of physics corresponding to proficiency certificate level is assumed.

1 Oscillation (6 hours)

- 1.1 Physical pendulum
  - 1.1.1 Bar pendulum
  - 1.1.2 Interchangeability of point of suspension and point of oscillation
  - 1.1.3 Minimum time period in case of physical pendulum
  - 1.1.4 Torsion pendulum
- 1.2 Damped and forced oscillation
  - 1.2.1 Damped harmonic oscillator
  - 1.2.2 Difference between free and damped oscillator
  - 1.2.3 Energy in damped oscillation
  - 1.2.4 Relaxation time
  - 1.2.5 Forced oscillation and resonance
  - 1.2.6 Sharpness of resonance
  - 1.2.7 Quality factor

2 Acoustics (3 hours)

- 2.1 Introduction
  - 2.1.1 Threshold of hearing and loudness
  - 2.1.2 Reverberation and reverberation time
  - 2.1.3 Absorption coefficient
  - 2.1.4 Sabine's law
  - 2.1.5 Conditions for good acoustics
- 2.2 Ultrasound
  - 2.2.1 Production (Piezoelectric) of ultrasound and its applications
  - 2.2.2 Test of structure and materials
  - 2.2.3 Medical uses

3 Heat and Thermodynamics (8 hours)

- 3.1 Quantity of heat
  - 3.1.1 Calorific value of foods and fuels
  - 3.1.2 Bomb calorimeter
  - 3.1.3 Specific heat of solid: Dulong-Petit law, Einstein's law
- 3.2 Nature of heat
  - 3.2.1 Degree of freedom
  - 3.2.2 Maxwell's law of equipartition of energy
  - 3.2.3 Atomicity of gases
  - 3.2.4 Vander-Waal's equation of real gases
  - 3.2.5 Critical constants
- 3.3 Thermodynamics
  - 3.3.1 Laws of thermodynamics
  - 3.3.2 Clapeyron latent heat equation
  - 3.3.3 Entropy and Third law of thermodynamics
  - 3.3.4 Negative energy
  - 3.3.5 Maxwell's thermodynamic relations
  - 3.3.6 Gibb's free energy and phase transitions
- 3.4 Heat and mass transfer
  - 3.4.1 Fourier's law of thermal conductivity
  - 3.4.2 Use of thermal conductivity in building sciences
  - 3.4.3 Thermal resistance
  - 3.4.4 Types of convection
  - 3.4.5 Law of diffusion
  - 3.4.6 Relation between Stefan's law and Newton's law of Cooling
  - 3.4.7 Pyrheliometer and Pyrometer

4 Optics (17 hours)

- 4.1 Geometrical optics
  - 4.1.1 Lens separation
  - 4.1.2 Chromatism in lens combination
- 4.2 Interference
  - 4.2.1 Interference in thin films (Reflected and transmitted light)
  - 4.2.2 Fringes produced by a wedge-shaped thin film
  - 4.2.3 Newton's rings (Both reflected and transmitted case)
  - 4.2.4 Determination of wavelength of light and refractive index of liquid by using Newton's rings.
- 4.3 Diffraction
  - 4.3.1 Introduction: Fresnel and Fraunhoffer's diffraction
  - 4.3.2 Fraunhoffer's diffraction at single slit
  - 4.3.3 Intensity distribution in the diffraction pattern due to a single slit
  - 4.3.4 Multiple slits, diffraction grating
  - 4.3.5 X-ray diffraction, X-rays in material testing

4.4 Polarization
- 4.4.1 Introduction: double refraction, Nichol prism (Construction and uses)
- 4.4.2 Retardation plate (Quarter and half wave plates), plane, elliptical and circular polarized light (Theoretical and mathematical explanation)
- 4.4.3 Optical activity, specific rotation

4.5 Laser
- 4.5.1 Introduction: Laser and ordinary light, properties of laser
- 4.5.2 Induced absorption, spontaneous and stimulated emission, active medium, population inversion, metastable state
- 4.5.3 Pumping (Types: Optical, electrical, chemical and thermal)
- 4.5.4 He-Ne laser, semiconductor laser
- 4.5.5 Uses of laser

4.6 Fiber optics
- 4.6.1 Introduction: Propagation of light wave
- 4.6.2 Types of optical fiber: Step index and graded index
- 4.6.3 Fiber transmission- Single and multimode, self-focusing, acceptance angle and numerical aperture
- 4.6.4 Applications

5 Electrostatics (8 hours)

5.1 Electric field
- 5.1.1 Electric field due to an electric dipole (Along axial line and equatorial line)
- 5.1.2 Electric dipole in an external electric field
- 5.1.3 Electric field due to linear electric quadrupole (Along axial line)
- 5.1.4 Electric field: A ring of charge, circular ring and disc of charge

5.2 Electric potential
- 5.2.1 Potential due to electric dipole
- 5.2.2 Potential due to linear quadrupole
- 5.2.3 potential due to continuous charge distribution, potential due to ring of charge and disc of charge

5.3 Capacitors
- 5.3.1 Cylindrical capacitor
- 5.3.2 Charging and discharging of capacitor
- 5.3.3 Capacitor with dielectrics: dielectrics and Gauss law
- 5.3.4 High intensity electrostatic fields: Uses and hazards (Xerography, inkjet, precipitation)

6 Electromagnetism (6 hours)

6.1 Electromagnetic induction
- 6.1.1 Faraday’s laws
- 6.1.2 Induction and energy transformation

6.1.3 Induced electric field
6.1.4 Self-induction and mutual induction
6.1.5 LR circuit
6.1.6 Energy stored in a magnetic field and energy density
6.1.7 Induced magnetic field: Modified Ampere's law and displacement current

6.2 Eddy current
6.2.1 Introduction
6.2.2 Applications: Induction cooker, electric guitar, metal detector and Eddy current breaking
6.2.3 Cyclotron and Synchrotron

7 Electromagnetic Waves (6 hours)

7.1 Maxwell's equations
7.1.1 Differential and integral forms
7.1.2 Conversion of Maxwell's equations from integral form to differential form and differential form to integral form
7.1.3 Maxwell's equations in different media

7.2 Applications
7.2.1 Wave equations: Non conducting and conducting medium and free space
7.2.2 Plane solution of wave equations, amplitude of electromagnetic waves, speed of electromagnetic waves, ratio of electric and magnetic fields
7.2.3 Continuity equation
7.2.4 Energy transfer and Poynting vector, radiation pressure

8 Photon and Matter Waves (6 hours)

8.1 Quantum physics
8.1.1 Inadequacy of classical mechanics and rise of quantum mechanics, quantization of energy
8.1.2 Group velocity and phase velocity, electrons and matter waves
8.1.3 de-Broglie wavelength, its applications
8.1.4 Heisenberg uncertainty principle and its applications
8.1.5 Wave functions and its significance

8.2 Schrodinger wave equation
8.2.1 Time dependent and independent equation
8.2.2 Probability distribution
8.2.3 One dimensional infinite potential well, particle in a box
8.2.4 Barrier tunneling (Reflection and transmission coefficient)

Tutorial **(15 hours)**

1. Oscillation

   Physical pendulum related numerical, torsional pendulum: Determination of moment of inertia and modulus of rigidity; Minimum time period and interchangeability of point of suspension and point of oscillation in bar pendulum

   Damped harmonic motion: Amplitude and energy related problems, energy loss and quality factor related problems

   Force harmonic motion: Amplitude and resonance frequency related problems

2. Acoustics

   Reverberation time calculation by using Sabine's relation, absorption coefficient, total absorbing power calculation, intensity level related problems

3. Heat and Thermodynamics

   Calculation of Calorific value, Einstein's law related problems, Maxwell's equipartition of energy related problems for mono, di and triatomic molecule; Calculation of critical constants, phase transition related problems; Newton's law of cooling related problems; Change in entropy related problems; Fourier's law of thermal conductivity related problems

4. Optics

   Combination of lens related problems for calculation of equivalent focal length, principal points, position of image; Achromatism related problems (for separation and joined cases)

   Interference: Interference in thin films, wedge shaped and Newton's rings related problems

   Diffraction: Intensity distribution from single slit related and diffraction grating related numericals

   Polarization: Specific rotation, wave plates (quarter and half) related problems

   Optical fiber: Refractive index for core and cladding, Numerical Aperture and acceptance angle calculations

5. Electrostatics

   Electric dipole related problems for electric field and potential; Electric dipole in an external electric field related problem; Electric quadrupole related numerical; Problems related to charged ring and disc for both electric field and electric potential; Calculation of numerical value of cylindrical capacitor; Determination of electric field, displacement vector and polarization vector in case of dielectric in a capacitor

6. Electromagnetism

   Determination of self-inductance of solenoid and toroid; Rise and decay related problems in LR circuit; Displacement current related numerical; Time period and maximum energy for a charged particle in cyclotron related problems

7. Electromagnetic waves

   Prove that velocity of electromagnetic wave is equal to velocity of light in free space; Intensity of electromagnetic waves related problems; Determination of maximum value of electric and magnetic fields due to electromagnetic wave; Radiation pressure related problems

8. Photon and matter waves

De-Broglie wavelength related problems; Heisenberg's uncertainty related numerical; Energy states calculation for infinite potential well; Transmission coefficient related numerical in finite potential barrier

Practical **(30 hours)**

1. To determine the acceleration due to gravity and radius of gyration of the given metal bar using bar pendulum
2. To determine the modulus of elasticity of the given material and moment of inertia of the circular disc about the wire as an axis passing through its center and perpendicular to its plane by using torsional pendulum
3. To determine the coefficient of thermal conductivity of a bad conductor by Lee's method
4. To determine the mechanical equivalent of heat by given method
5. To determine the wavelength of the sodium light using Newton's rings
6. To determine the wavelength of sodium light using wedge-shaped method
7. To determine the wavelength of LASER light using diffraction grating and hence determine the particle size of lycopodium powder
8. To determine the focal length of two lenses when they are separated by some finite distance
9. To determine the chromatic aberration of a convex lens between red and blue colors
10. To determine the capacitance of the given capacitor by the method of charging and discharging through resistor
11. To plot the graph between frequency and current in LCR series circuit and hence determine the quality factor of the circuit
12. To study the growth and decay of current in LR circuit then determine the self-inductance of the given inductor
13. To determine the dielectric constant of the given material

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below**:**

Chapter	Hours	Marks Distribution*
1	6	6
2	3	4
3	8	7
4	17	17
5	8	9
6	6	5
7	6	6
8	6	6
Total	**60**	**60**

*There may be minor deviation in mark distribution.

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