ENGINEERING MATHEMATICS III
ENSH 201

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

Course Objectives:
The objective of this course is to equip students with understanding and practical application of Fourier series, Fourier transform, function of complex variable, partial differential equations and obtaining mathematical models and Z- transform.

1 Fourier Series and Fourier Transform (12 hours)

1.1 Review of periodic, odd and even functions
1.2 Fourier series of a function over an interval of length 2ℓ and 2π; Euler's formula, Dirichlet's condition for uniform convergence of Fourier series, Fourier series of discontinuous functions
1.3 Half range Fourier sine and cosine series
1.4 Complex form of Fourier series; frequency and amplitude of a function
1.5 Fourier integral theorem, Fourier sine and cosine integrals, complex form of Fourier integral
1.6 Fourier transform, Fourier sine transform, Fourier cosine transform and their inversion formulas
1.7 Fourier transform of the derivative of a function
1.8 Relation between Fourier and Laplace transform

2 Functions of Complex Variable (12 hours)

2.1 Intuitive idea of limit, continuity and differentiability of functions of complex variable
2.2 Analytic functions, the Cauchy Reimann equations both in Cartesian and polar form, construction of analytic functions
2.3 Harmonic functions, the orthogonal system
2.4 Application of analytic functions in flow problems
2.5 Transformation (Mapping), conformal mapping, translation, rotation and magnification; inversion, bilinear transformation
2.6 Complex integration, simply and multiply connected regions, Cauchy's integral theorem and formula
2.7 Series of complex terms, power series, circle of convergence and radius of convergence, Taylor's and Laurent's series
2.8 Zeros, singularities, poles; residue at poles, Cauchy's residue theorem and evaluation real and improper integrals

3 Partial Differential Equations (5 hours)

3.1 Definition and formation of partial differential equations
3.2 Partial differential equations solvable by direct integration
3.3 Linear partial differential equation of the first order, Lagrange's linear equations and their solution
3.4 Nonlinear partial differential equation of first order; equations of the form $f(p,q)=0$, $z=px+qy+f(p,q)$, $f(z,p,q)=0$, $f_1(x,p)=f_2(y,q)$
3.5 Charpit's method of solving nonlinear partial differential equations of first order

4 Modelling through Partial Differential Equation (10 hours)

4.1 Second order partial differential equation and classification
4.2 One-dimensional wave equation
4.3 One-dimensional heat equation
4.4 Two-dimensional heat equation, Laplace equation in Cartesian form
4.5 Mass balance equation; equation of continuity in fluid dynamics, Navier-Stoke's equation
4.6 Momentum balance equation; Euler's equation of motion for inviscid fluid flow

5 Z- transform and its Applications (6 hours)

5.1 Representation of a sequence and basic operations
5.2 Definition and existence of Z-transform, Z-transform of standard sequences
5.3 Properties of Z-transform; linearity, change of scale, shifting properties, initial and final value theorems
5.4 Differentiations of Z-transform
5.5 Inverse Z-transform; partial fraction and residue methods
5.6 Convolution of sequences, convolution of Z- transform
5.7 Difference equations, application of Z-transform to solve difference equations and to find the sum of series

Tutorial (30 hours)

1. Problems related to find period and identify odd and even functions
2. Exercises on Fourier series representation over intervals 2l and generalization into 2π
3. Exercises related to Fourier series for discontinuous functions
4. Exercises related to half range Fourier series
5. Exercises related to complex form of Fourier series
6. Exercises related to Fourier integral, Fourier sine and cosine integral
7. Exercises related to Fourier transform, Fourier sine and cosine transform and inversion
8. Exercises related to Fourier transform of derivatives and boundary value problems.

9. Exercises on application of C-R equations and construction of analytic functions
10. Exercises on application of analytic functions to flow problems
11. Exercises on mapping covering example of each mapping
12. Exercises on application of Cauchy integral theorem and formula
13. Exercises related to expansion of a function in Taylor and Laurent series
14. Exercises related to complex integration by using Cauchy's residue theorem
15. Exercises on solution of partial differential equation by direct integration
16. Exercises related to Lagrange's equation and PDE's as mentioned in 3.4
17. Exercises related to solution of one dimensional wave equation, one dimensional heat equation, two dimensional equation
18. Exercises related to Z-transform, application of properties
19. Exercises related to inverse Z-transform
20. Exercises related to solve difference equations by Z-transform
21. Exercises related to find sum of series by Z- transform

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	12	18
2	12	18
3	5	6
4	10	10
5	6	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Jeffery A. (2002). Advanced Engineering Mathematics (2nd edition). San Diego: Harcourt Academic Press.
2. O'Neill, P.V. (2011). Advanced Engineering Mathematics (7th edition). India: Thompsons, USA/Baba Baghanath Printers.
3. Kreyszig, A. (2020). Advanced engineering Mathematics (10th edition). USA: Wiley Publications.
4. Sastry S.S. (2014). Engineering Mathematics vol I and II (4th edition). India: PHI Learning Pvt. Ltd.
5. Wylie C., Barrett L. (1988). Advanced Engineering Mathematics (5th edition). McGraw Hill.
6. Dutta, D. (2006). A text book of Engineering Mathematics Vol I and II (2nd edition). India: New Age International Publishers.
7. Ogata, K. (2015). Discrete Time Control System (2nd edition). Pearson Publications.
8. Sharma, Sanjay. (2017). Signals and Systems (9th edition). India: S.K.Kataria and Sons.

CONCRETE TECHNOLOGY
ENCE 205

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

Course Objectives:
The objective of this course is to build the basic understanding of students on concrete ingredients and their properties, properties of fresh and hardened concrete, quality assurance and quality control in concreting works, concrete grade and concrete mix design, and special concrete. After completing this course, students should be able to develop competency in understanding on behavior of concrete, concreting operation, tests on concrete, and mix design.

1 Concrete and Constituents of Concrete (6 hours)

1.1 Introduction to concrete and use of concrete in structures
1.2 Constituents of concrete
   1.2.1 Aggregates (Properties and their gradation)
   1.2.2 Cement: Compound composition of cement (Bogue's compound) and their properties, hydration of cement, strength of cement
   1.2.3 Water (Quality/requirements of water for concrete)
   1.2.4 Admixtures: Chemical admixtures and mineral admixtures, use of chemical admixtures (Plasticizers, Super-plasticizers, accelerator, retarder, air entraining agents, water proofer), properties, use and different types of mineral admixtures (Fly ash, blast furnace slag, silica fume, rice husk ash, meta-kaolin)
1.3 Structure of concrete: Concrete as three phase system (aggregate, hydrated cement paste and transition zone phases)

2 Properties of Fresh Concrete and Concreting Operations (4 hours)

2.1 Water-cement ratio
2.2 Workability and its tests (Slump test, compaction factor test, Vee-Bee consistency test, flow table test)
2.3 Segregation, bleeding and their effects
2.4 Concreting operations (Batching, mixing, handling, placing, compaction, finishing, curing and formwork removal)
2.5 Concreting in extreme temperatures and its mitigation
2.6 Mass concreting issues and their mitigation

3 Mix Design of Concrete (6 hours)

3.1 Compressive strength of concrete and grade designation
3.2 Variability of concrete strength, characteristic strength and grade of concrete
3.3 Introduction to nominal Mix
3.4 Mix design (IS code, British code, ACI methods)

4 Properties of Hardened Concrete (6 hours)

4.1 Load-deformation behavior of hardened concrete, moduli of elasticity
4.2 Shrinkage and creep
4.3 Impact, cyclic loading and fatigue
4.4 Effect of water cement ratio (Abram's law, effect of porosity and aggregate size)
4.5 Effect of gel/space ratio
4.6 Concrete maturity
4.7 Durability of concrete: Physical and chemical cause of deterioration, effect of water and permeability, sulphate attack, attack by sea water, alkali silica reaction (AAR/ASR), chloride ion penetration, carbonation, corrosion of steel in concrete

5 Testing of Concrete, Quality Assurance and Quality Control (5 hours)

5.1 Strength of concrete (Tensile, compressive, shear and bond strength)
5.2 Compressive strength test
5.3 Tensile strength test (Direct, splitting and flexural)
5.4 Acceptance criteria
5.5 Non-destructive tests (Schmidt rebound hammer test, ultrasonic pulse velocity test, and resistivity test)
5.6 Quality assurance and quality control; Testing and monitoring

6 Special Types of Concretes (3 hours)

6.1 Light weight concrete (Aerated concrete, cellular concrete, no fines concrete)
6.2 High density/heavy weight concrete (Self compacting concrete, ferro-cement concrete)
6.3 Fiber reinforced concrete (Steel fibers, glass fibers, carbon fibers, organic fibers)
6.4 Self-healing concrete
6.5 High performance concrete (High strength concrete, abrasion resistant concrete)
6.6 Emerging concrete technologies

Practical (30 hours)

1. Gradation and properties of aggregates
2. Nominal mix (IS code provision)

3. Concrete mix design: IS code method, British code method, ACI method
4. Workability tests: Slump test, compaction factor test, Vee-Bee time test
5. Testing of concrete cubes, cylinders, and prisms etc.
6. Non-destructive testing (Schmidt rebound hammer test and ultrasonic pulse velocity test)

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	6
2	4	4
3	6	6
4	6	6
5	5	5
6	3	3
Total	**30**	**30**

* There may be minor deviation in marks distribution.

References

1. Neville, A.M. (2016). Properties of Concrete, (5th edition). Pearson Education.
2. Shetty, M. S. (2006). Concrete Technology. S. Chand & Co.
3. M. L. Gambhir, (2017). Concrete Technology. Tata Mc Graw Hill Publishers.
4. Mehta P. K., Monteiro J. M. (2014). Concrete: Micro structure, Properties and Materials. McGraw Hill Publishers
5. IS 383:2016 Coarse and Fine Aggregate Specification for Concrete Specification
6. IS 456:2000 Plain and Reinforced Concrete – Code of Practice
7. IS 10262:2019 Concrete Mix Proportioning Guidelines
8. IS 2386 (Part 1, 3, 4) Methods of Test for Aggregates for Concrete
9. IS 516 (2021) Methods of Tests for Strength of Concrete
10. IS 1199 Methods of Sampling and Analysis of Concrete
11. IS 5816 Splitting Tensile Strength of Concrete – Method of Test
12. ACI 211.1-91: Standard Practice for Selecting Proportions for Normal, Heavy weight, and Mass Concrete.
13. BS 5328: Part 2: 1997, Concrete-Part 2: Methods for Specifying Concrete Mixes.

ENGINEERING SURVEY II
ENCE 203

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

Course Objectives:
The objective of this course is to familiarize surveying methods and techniques used for design and construction of civil engineering projects. This course will provide basic knowledge of land measurement and surveying techniques giving specific emphasis to plane surveying. The course will make students able to learn and understand the theory and field procedures by applying suitable surveying methods to prepare engineering maps.

1 Traversing and Area Calculation (8 hours)

1.1 Needs, significance and types of traversing
1.2 Specification for horizontal and vertical control of traverse
1.3 Fieldworks for traversing and traverse field notes
1.4 Traverse computation
1.5 Plotting of traverse, concept of map integration
1.6 Field problems and instructions
1.7 Area calculation by coordinate and double meridian distance method

2 Indirect Leveling and Contouring (5 hours)

2.1 Principle of plane trigonometric surveying
2.2 Determination of heights and distances of inaccessible objects
2.3 Reciprocal trigonometrical leveling
2.4 Instruction on field works
2.5 Introduction to contouring
2.6 Establishment of controls
2.7 Contour interval and characteristics of contour
2.8 Methods of locating contours
2.9 Interpolation of contours
2.10 Uses of contour maps
2.11 Volume calculation by average-end-area and prismoidal methods

3 Orientation and Field Astronomy (5 hours)

3.1 Introduction to datum system
3.2 Analytical intersection and resection
3.3 Two points and three-point resection and their significance
3.4 Instruction on field application
3.5 Introduction of astronomy, definition of terms
3.6 Geographical coordinate system
3.7 Map projection system of Nepal
3.8 Use of astronomy in surveying and mapping

4 Route Survey (10 hours)

4.1 Types of curves and their uses
4.2 Simple circular curves and elements
4.3 Layout of simple circular curve by linear and angular method
4.4 Transition curve, characteristics, types and its elements
4.5 Layout of transition curve by linear and angular method
4.6 Elements of composite curves and setting out techniques
4.7 Vertical curve, requirements, equation of parabolic curve
4.8 Vertical curve layout by parabolic method

5 Photogrammetry and Drone Surveying (5 hours)

5.1 Photogrammetric as a branch of surveying
5.2 Scale of vertical photograph, relief displacement
5.3 Merits and limitation of photogrammetry
5.4 Drones and their development; drone types
5.5 Drone regulation in Nepal and flight permission
5.6 Features of drone mapping and surveying
5.7 Drone survey planning and techniques
5.8 Post processing and data analysis of drone survey
5.9 Application of drone survey

6 Geospatial Technologies in Civil Engineering (4 hours)

6.1 Global positioning system (GPS)
6.2 Components, working principles and uses of GPS
6.3 Differential GPS and its uses in civil engineering for mapping
6.4 Instructions to field applications
6.5 Types of remote sensing and electromagnetic radiation (EMR)
6.6 Interaction of EMR with earth surface features
6.7 Field application and instruction of remote sensing
6.8 Geographic information system (GIS) and types of GIS
6.9 Application of GIS to civil engineering projects

7 Hydrographic Surveying (4 hours)

7.1 Hydrographic survey, its terminology and application
7.2 Vertical and horizontal control
7.3 Measurement of depth and velocity of flow and discharge
7.4 Location of a point by orientation

8 Specialized Civil Engineering Surveys (4 hours)

8.1 Principle, stage and requirements of setting out
8.2 Horizontal and vertical control for setting out works
8.3 Building setting out by linear and angular method
8.4 Bridge and sewer line layout work
8.5 Norms and standards for road alignment survey
8.6 IP and corridor method of alignment surveying
8.7 Basics of tunnel surveying
8.8 Uses of gyroscope for tunnel surveying
8.9 Methods of transferring centerline in tunnel
8.10 Basics of water supply and canal surveying

Tutorial **(15 hours)**

1. Traversing and area calculation; computation of major and minor traverse; calculation of area by coordinate and DMD method
2. Indirect leveling, calculation and interpolation of contour
3. Orientation and field astronomy problems related to intersection, two point and three point problems by Collins and Tienstra's methods
4. Different problems related to simple circular, transition, composite and vertical curves
5. Calculation of flow velocity and discharge obtained by different measurement techniques
6. Calculations of chainage of route alignments, horizontal and vertical control

Assignments

1. Digital data recording plotting by software to produce the topographic map

Practical **(60 hours)**

1. Traverse survey by digital data recording using total station (Record horizontal angle and mention manual calculation), plotting of detailing by manual and any computer software; RL transfer to station
2. Intersection and resection using total station
3. Trigonometric leveling
4. Contouring - Indirect method
5. Setting out of simple circular, transition, composite and vertical curves
6. Minimum three room building setting out by linear and angular methods
7. Establishment of control points by using DGPS nearby working area

8. Flying of drone, taking image by using drone and image processing for terrain generation
9. Demonstration on application of GPS and GIS
10. Photogrammetry lab visit

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	8	12
2	5	6
3	5	6
4	10	16
5	5	6
6	4	5
7	4	5
8	4	4
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Bannister, A., Raymond S., Baker R. (1998). Surveying. 7th Edition. Pearson.
2. Punmia B. C., Jain A., Kr., Jain A. K. (2005). Surveying VOL I, VOL II & VOL III. Laxmi publication.
3. Wolf, P.R., Brinker, R.C. (2010). Elementary Surveying. Harper Collins college publishers.
4. Basak N.N. (2004). Surveying and Levelling. Tata McGraw-Hill.
5. Agor R. (1980). A Text Book of Surveying and Levelling. Delhi: Khanna publisher.
6. Duggal S. K. (2013). Surveying: Volume 1& 2. Tata McGraw-Hill.
7. Dhakal B. B., Karki B. K. (2019). Engineering Surveying I & II, Second edition. Kathmandu: Heritage publication and distributors.
8. Basnet N., Basnet M. (2011). Basic Surveying I & II. Kathmandu: National Book Center.

COMPUTER AIDED CIVIL DRAWING
ENCE 204

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

Course Objectives:
The objective of this course is to train students with computer aided design and drafting of civil engineering structures. The course will teach students to extract dimensions from existing computer aided drawings, enabling them to interpret and utilize these drawings effectively. Students will be equipped to create drawings with site plans and structural details applying computer aided techniques to produce precise and professional documents for civil engineering projects.

1 Introduction (2 hours)

1.1 Computer aided design and drafting
1.2 Application of computer aided drawings in civil engineering
1.3 Computer aided drawing software
1.4 Three-dimensional drawing software

2 Autodesk AutoCAD (8 hours)

2.1 Overview of the two-dimensional AutoCAD interface
2.2 Coordinate system, units and scales
2.3 Drawing and editing (Commands and tools)
2.4 Layers and blocks
2.5 Annotation and dimensioning
2.6 Layouts and printing
2.7 Three dimensional drawings

3 Computer Aided Civil Engineering Drawings (16 hours)

3.1 Location map
3.2 Land measurement and area calculation
3.3 Building drawing (Load bearing and reinforced cement concrete)
3.4 Underground water tank, septic tank and soak pit
3.5 Road, retaining wall and side drain
3.6 Irrigation canal and weir/barrage
3.7 Slab culvert and T-beam bridge
3.8 Title block and legends
3.9 Importing, exporting and plotting

4 Building Information Modeling (4 hours)

4.1 Concept, processes and utilization
4.2 Standards and regulations
4.3 Building information modeling versus computer aided design and drawing
4.4 Common data environment

Practical (45 hours)

1. Preparation of a two-story residential load-bearing building on the given land
2. Preparation of a two-story RCC building on the given land
3. Preparation of a RCC slab culvert drawings of given span
4. Preparation of contour map from given survey data at suitable contour interval and scale
5. Common data environment

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	2	5
2	8	8
3	16	13
4	4	4
Total	**30**	**30**

* There may be minor deviation in marks distribution.

References

1. Omura, G. (2006). Mastering AutoCAD 2005 and AutoCAD LT 2005. Germany: Wiley.
2. Tickoo, S. (2005). Autocad 2005: A Problem Solving Approach. United States: Delmar Learning.
3. Sacks, R., Eastman, C., Lee, G., & Teicholz, P. (2018). BIM handbook: A guide to building information modeling for owners, designers, engineers, contractors, and facility managers. John Wiley & Sons.
4. Civil engineering drawings provided by subject teacher

THEORY OF STRUCTURES I
ENCE 202

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

Course Objectives:
The objective of this course is to develop concepts and analytical skills to compute structural responses (Stresses and deformations) in determinate structures subjected to static loads by manual calculation as well as matrix method of analysis using computer software.

1 Introduction (3 hours)

1.1 Types of structures based on analysis perspective
1.2 Idealization of structures, threats and responses
1.3 Review of determinacy, indeterminacy and stability of plane structures
1.4 Application of determinate systems in civil engineering infrastructures

2 Strain Energy Method (5 hours)

2.1 Work and complementary work
2.2 Strain energy and complementary strain energy
2.3 Strain energy due to axial, shear, bending and torsion
2.4 Deformation of beams and frames by real work method
2.5 Limitations of the real work method
2.6 Strain energy due to gradually and suddenly applied direct load: Dynamic multipliers

3 Virtual Work Method (6 Hours)

3.1 Introduction to virtual work
3.2 Derivation of virtual work equation
3.3 Displacements by the methods of virtual work
3.4 Direct axial, shear, bending and torsion effects
3.5 Deformation of trusses due to external loads, temperature effect and misfits
3.6 Deformation of beams and fames due to external loads and temperature effects
3.7 Deformation of beams and frames due to support settlements
3.8 Betti’s law and Maxwell’s reciprocal theorems
3.9 Application of different effects in beam, frame and truss

4 Deflection of Beams (7 hours)

4.1 Importance of deflection evaluation
4.2 Macaulay's method
4.3 Moment-area method: Derivation of theorems
4.4 Conjugate-beam method
4.5 Deflections by the method of superposition
4.6 Deflection evaluation of different determinate beams
4.7 Application of deflection

5 Influence Lines for Simple Structures (9 Hours)

5.1 Importance of influence lines
5.2 Concept of moving static loads and influence line diagrams (ILD)
5.3 Influence lines for support reactions and support moments
5.4 Influence lines for shear force and bending moment in beams
5.5 Influence lines for support reactions and member forces in trusses
5.6 ILD for indirect load applications (Panel loadings)
5.7 Qualitative ILD using Muller-Breslau principle
5.8 Use of influence line diagrams
  5.8.1 Determination of reactions, bending moments and shear forces (Structural quantity diagram) from ILD due to different loadings: Point load, distributed load, couple, standard load trains
  5.8.2 Most critical position of a loading system for maximum internal force/moment at a beam section
  5.8.3 Determination of most critical position of a loading system for absolute maximum internal forces

6 Statically Determinate Arches (6 hours)

6.1 Introduction and type of arches
6.2 Three-hinged structures with supports at the same and different levels
6.3 Determination of support reactions, shear forces, normal forces and bending moments
6.4 Analysis of three-hinged arches by the graphical method
6.5 Use of ILD for reactions, bending moments, radial shear forces and normal thrust

7 Suspension Cable Systems (7 hours)

7.1 Introduction and type
7.2 Funicular shape of cable
7.3 Catenary cables and general cable theorem
7.4 General cases of parabolic cables and their analysis

7.5 Elements of a simple suspended and suspension bridges
7.6 Analysis of three-hinged stiffening girder
7.7 Use of influence line diagrams
7.8 Basics of tower structures, wind cables and ties

8 Simple Space Truss (2 hours)

8.1 Introduction and importance of space truss
8.2 Boundary conditions and types of supports
8.3 Analysis of simple space truss by tension coefficient methods

Tutorial (30 hours)

1. Strain energy due to axial, shear, bending, and torsion
2. Deformation of beams and frames by real work method
3. Displacements by the methods of virtual work
4. Deformation of trusses due to external loads, temperature effect and misfits
5. Deformation of beams and fames due to external loads and temperature effects
6. Deformation of beams and frames due to support settlements
7. Deflection of beams by different methods
8. Influence line diagrams for support reactions, shear force and bending moment
9. Influence lines for support reactions and member forces in trusses
10. Determination of reactions, bending moments and shear forces (Structural quantity diagram) from ILD due to different loadings: Point load, distributed load, couple, standard load trains
11. Determination of support reactions, shear forces, normal forces and bending moments of three-hinged arches
12. ILD for reactions, bending moments, radial shear forces and normal thrust of three-hinged arches
13. Analysis of parabolic cables
14. Analysis of three-hinged stiffening girder
15. Analysis of simple space truss by tension coefficient methods

Practical (15 hours)

1. Deflection of beams and frames
2. Measurement of reactions in three-hinged arches under different loading arrangements
3. Analysis of plane truss under different loading arrangements
4. Experimental analysis of suspension bridges under different loading arrangements
5. Simulation of influence lines for beams, girders and frames under different loading arrangements
6. Simulation of displacement measurement in statically determinate plane frame

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	5	7
3	6	8
4	7	9
5	9	12
6	6	8
7	7	10
8	2	2
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Hibbler, R.C. (2008). Structural Analysis. Prentice Hall.
2. Norris, C.H. Wilbur, J.B., Utku S. (1977). Elementary structural Analysis. 3rd Edition. New York: McGraw-Hill Book Co.
3. Reddy, C.S. (2017). Basic Structural Analysis. Tata McGraw-Hill Education.
4. Wong Y. Yang et. al. (2005). Applied Numerical Methods using MATLAB. John Willey & Sons.
5. Parajuli H. R. and Ojha B. (2024). Structural Analysis-I, Determinate Structures. Kathmandu: Heritage Publishers & Distributors.
6. Darkov, A., Kuznetsov V. (2011). Structural Mechanics. Gordon and Breach 1969
7. West, H.H. (1980). Analysis of Structures. John Wiley & Sons Inc.
8. Devdas M. (2008). Structural Analysis. Narosa Publishing House.

FLUID MECHANICS
ENCE 201

Lecture : 4 **Year : I**
Tutorial : 2 **Part : II**
Practical : 3/2

Course Objectives:
To provide students with a deep understanding of the principles governing the behavior of fluids, encompassing both liquids and gases. This branch of physics and engineering aims to elucidate how fluids behave under various conditions and to equip students with the knowledge and skills necessary to analyze and solve practical problems related to fluid flow. It also enables students to apply fluid mechanics concepts to the design, analysis, and optimization of engineering systems involving fluids, such as pipelines, pumps, turbines and hydraulic systems.

1 Fundamental Concepts of Fluids (8 hours)

1.1 Definition and characteristics of fluid, distinction between liquid and gases
1.2 Thermodynamic system, control volume and continuum concept
1.3 Basic fluid properties: Mass density, specific weight, specific gravity, cavitation, vapor pressure, surface tension, capillarity and viscosity
1.4 Isothermal and adiabatic compressibility
1.5 Liquid-vapour phase transition, Isobaric evaporation during heating, isothermal condensation during cooling, vapour pressure vs temperature.
1.6 Fluid pressure and types, pressure head and basic pressure laws (Pascal law, hydrostatic law)
1.7 Pressure measurement: Manometers (piezometer, U-tube manometer and micro manometers)

2 Fluid Statics (10 hours)

2.1 Hydrostatics forces on plane and curved surfaces; concepts
2.2 Hydrostatic thrusts on submerged surfaces; total pressure and centre of pressure (Plane and curve surfaces)
2.3 Pressure diagram (plane and curve surfaces)
2.4 Computation of pressure forces on gates, dams and civil hydraulic structures (Plane and curve cases)
2.5 Buoyancy and Archimedes principle, floatation concept
2.6 Condition of equilibrium: Stability of submerged and floating bodies
2.7 Metacenter and determination of metacentric height (Analytical and experimental method)

2.8 Liquid in relative equilibrium: Liquid in a container subjected to uniform acceleration in horizontal, vertical and inclined directions; uniform radial acceleration about vertical axis

3 Fluid Flow Kinematics (8 hours)

3.1 Lagrangian and Eulerian concept in fluid flow, classification of flow
3.2 Description of flow patterns: Streamlines, streak lines, path lines (Equations and practical examples)
3.3 Stream tube, stream functions and velocity potentials functions, total acceleration
3.4 Conservation principle of mass, continuity equation of Cartesian and polar co- ordinates
3.5 Discharges and mean velocity of flow

4 Fluid Dynamics (6 hours)

4.1 Various forces acting on a fluid in motion (Gravitational, pressure, viscous, turbulent, surface tension and compression)
4.2 Concept of Reynold and Navier-Stokes' equation of motion
4.3 Euler's equation of motion and its application
4.4 Bernoulli's equation: Concept, assumptions, application examples
4.5 Momentum and fluid flow, linear momentum equations for two-dimensional flow and moment of momentum equation

5 Application of Energy and Momentum Equation (12 hours)

5.1 Flow measurement devices: Venturi-meter (Horizontal, inclined and vertical), orifice meter, nozzle meter and Pitot tube (Working principal, governing equations and application examples)
5.2 Flow through orifices: Small orifice, large orifice, partially and totally submersed orifices (Equations and examples)
5.3 Hydraulic coefficients and their determinations
5.4 Flow over notches and weirs, discharge equations, concept of end contraction and approach velocity
5.5 Force exerted by jets striking a flat plate and moving (Plane and curve) vanes
5.6 Force exerted on pipe bends and closed conduits

6 Dimensional Analysis and Physical Modelling (8 hours)

6.1 Introduction to dimensional analysis (Physical quantity and their dimensions)
6.2 Methods of dimensional analysis: Rayleigh’s method and Buckingham’s π-theorem
6.3 Applications of dimensional analysis in fluid flow problems

6.4 Concept of physical modelling and its relation to dimensional analysis
6.5 Types of similarities
6.6 General model laws, application of Reynold's and Froude's model law in civil engineering

7 Flow Through Submerged Body and Boundary Layer Theory (8 hours)

7.1 Description of boundary layer and its thickness (Flat plate only)
7.2 Laminar and turbulent boundary layer on a flat plate with zero pressure gradient
7.3 Friction drags for laminar and turbulent boundary layer, engineering examples
7.4 Effect of pressure gradient and flow separation concept
7.5 Concept of drag and lift (Types and formulas)
7.6 Drag on cylinder and flat plate, application in engineering

Tutorial (30 hours)

1. Fluid Properties, manometers and pressure
2. Hydrostatic force calculations for plane and curved surface
3. Buoyancy and liquid in relative equilibrium
4. Kinematics (Streamline, streak line and path line) and mean velocity and discharge
5. Application of Bernoulli's equation
6. Flow measurement and flow through orifices and notches and weirs
7. Momentum equation on flat or curved plate, pipe bends etc.
8. Dimensional analysis and physical modelling
9. Boundary layer and drag and lift
10. Use of CFD (Some available software) in fluid flow calculations (Demo or few hands on exercises)

Practical (22.5 hours)

1. Determination of viscosity, specific gravity of fluid
2. Hydrostatic force on plane and curved surface
3. Buoyancy and floatation
4. Stream lines and path lines with the help of dye and cameras
5. Verification of Bernoulli's equation
6. Force of jets on flat and curved vanes
7. Physical model making (Simple conceptual related to civil engineering)

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	8	8
2	10	14
3	8	6
4	6	6
5	12	12
6	8	8
7	8	6
Total	**60**	**60**

* There may be minor deviation in marks distribution.

Reference

1. White, F.M. (2016). Fluid Mechanics. McGraw-Hill.
2. Dixon, S.L., Hall, C. (2014). Fluid Mechanics and Thermodynamics of Turbomachinery. Butterworth-Heinemann.
3. Munson, B.R., Young, D.F., Okiishi, T.H. (2012). Fundamentals of Fluid Mechanics. John Wiley and Sons.
4. Modi, P. N., Seth, S. M. (2017). Hydraulics and Fluid Mechanics. Standard book house.
5. Borgnakke C. Sonntag R.E. (2019). Fundamental of Thermodynamics, John Wiley and Sons.
6. Sangroula D.P. (2019). Fundamental of Fluid Mechanics.

NUMERICAL METHODS
ENSH 202

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

Course Objectives:
The objective of this course is to equip students with a thorough understanding of numerical methods, focusing on their application in obtaining approximate solutions to complex mathematical problems commonly encountered in science and engineering. Emphasizing algorithm development, programming, and visualization techniques, the course enables students to apply computational approaches effectively, enhancing their problem-solving capabilities in real-world applications.

1 Solution of Non-Linear Equations (7 hours)

- 1.1 Errors and accuracy in numerical computations
- 1.2 Bisection method
- 1.3 Regula Falsi method and secant method
- 1.4 Newton Raphson method
- 1.5 Fixed point iteration method
- 1.6 Comparison of the methods (Bracketing vs open-ended methods and rates of convergence)
- 1.7 Solution of system of non-linear equations
  - 1.7.1 Direct approach
  - 1.7.2 Newton Raphson method

2 Solution of System of Linear Algebraic Equations (8 hours)

- 2.1 Direct methods
  - 2.1.1 Gauss Jordan method
  - 2.1.2 Gauss elimination method, pivoting strategies (Partial and complete)
  - 2.1.3 Matrix inverse using Gauss Jordan and Gauss elimination methods
  - 2.1.4 Factorization methods (Do-Little’s method and Crout’s method)
- 2.2 Iterative methods
  - 2.2.1 Jacobi’s method
  - 2.2.2 Gauss-Seidal method
- 2.3 Determination of largest and smallest Eigen values and corresponding vectors using the power method

3 Interpolation (9 hours)

- 3.1 Polynomial Interpolation
  - 3.1.1 Finite differences (Forward, backward, central and divided differences)
  - 3.1.2 Interpolation with equally spaced intervals: Newton’s forward and backward difference interpolation, Stirling’s and Bessel’s central difference interpolation
  - 3.1.3 Interpolation with unequally spaced intervals: Newton’s divided difference interpolation, Lagrange interpolation
- 3.2 Least square method of curve fitting
  - 3.2.1 Linear form and forms reducible to linear form
  - 3.2.2 Quadratic form and forms reducible to quadratic form
  - 3.2.3 Higher degree polynomials
- 3.3 Cubic spline interpolation
  - 3.3.1 Equally spaced interval
  - 3.3.2 Unequally spaced interval

4 Numerical Differentiation and Integration (6 hours)

- 4.1 Numerical differentiation
  - 4.1.1 Differentiation using polynomial interpolation formulae for equally spaced intervals
  - 4.1.2 Local maxima and minima from equally spaced data
- 4.2 Numerical integration
  - 4.2.1 Newton Cote’s general quadrature formula
  - 4.2.2 Trapezoidal rule, Simpson’s 1/3 and 3/8 rules, Boole’s rule, Weddle’s rule
  - 4.2.3 Romberg integration
  - 4.2.4 Gauss-Legendre integration (up to 3-point formula)

5 Solution of Ordinary Differential Equations (ODE) (8 hours)

- 5.1 Initial value problems
  - 5.1.1 Solution of first order equations: Taylor’s series method, Euler’s method, Runge-Kutta methods (Second and fourth order)
  - 5.1.2 Solution of system of first order ODEs via Runge-Kutta methods
  - 5.1.3 Solution of second order ODEs via Runge-Kutta methods
- 5.2 Two-point boundary value problems
  - 5.2.1 Shooting method
  - 5.2.2 Finite difference method

6 Solution of Partial Differential Equations (7 hours)

- 6.1 Introduction and classification
- 6.2 Finite difference approximations of partial derivatives
- 6.3 Solution of elliptic equations
  - 6.3.1 Laplace equation
  - 6.3.2 Poisson's equation
- 6.4 Solution of parabolic and hyperbolic equations
  - 6.4.1 One-dimensional heat equation: Bendre-Schmidt method, Crank-Nicolson method
  - 6.4.2 Solution of wave equation

Tutorial **(15 hours)**

1. Solution of non-linear equations
2. Solution of system of linear algebraic equations
3. Polynomial interpolation
4. Least square method of curve fitting
5. Cubic spline interpolation
6. Numerical differentiation
7. Numerical Integration
8. Solution of ordinary differential equations (Initial value problems)
9. Solution of ordinary differential equations (Boundary value problems)
10. Solution of partial differential equations

Practical **(45 hours)**

Programming language to be used: Python
Results to be visualized graphically wherever possible
Practical report contents: Working principle, Pseudocode, Source code, Test Cases

1. Basics of programming in Python:
   - Basic input/output
   - Basic data types and data structures
   - Control flow
   - Functions and modules
   - Basic numerical and scientific computation
   - Graphical visualization
2. Solution of Non-linear equations:
   - Bisection method
   - Secant method
   - Newton-Raphson
   - System of non-linear equations using Newton-Raphson method
3. System of linear algebraic equations:
   - Gauss Jordan Method
   - Gauss elimination method with partial pivoting
   - Gauss-Seidal method
   - Power method

4. Interpolation
   - Newton's forward difference interpolation
   - Lagrange interpolation
   - Least square method for linear, exponential and polynomial curve fitting
   - Cubic spline interpolation
5. Numerical Integration
   - Trapezoidal rule
   - Simpson's 1/3 rule or Simpson's 3/8 rule
   - Boole's Rule or Weddle's Rule
   - Gauss-Legendre integration
6. Solution of Ordinary Differential Equations:
   - Runge-Kutta fourth order method for first order ODE
   - Runge-Kutta fourth order method for system of ODEs / 2nd order ODE
   - Solution of two-point boundary value problem using Shooting method
   - Solution of two-point boundary value problem using finite difference method
7. Solution of partial differential equations using finite difference approach:
   - Laplace equation using Gauss-Seidal iteration
   - Poisson's equation using Gauss-Seidal iteration
   - One-dimensional heat equation using Bendre-Schmidt method
   - One-dimensional heat equation using Crank-Nicholson method

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	7	10
2	8	10
3	9	10
4	6	10
5	8	10
6	7	10
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Chapra, S. C., Canale, R. P. (2010). Numerical Methods for Engineers (6th edition). McGraw-Hill.
2. Kiusalaas, J. (2013). Numerical Methods in Engineering with Python 3 (3rd edition). Cambridge University Press.
3. Grewal, B. S. (2017). Numerical Methods in Engineering & Science (11th edition). India: Khanna Publishers.
4. Yakowitz, S., Szidarovszky, F. (1986). An Introduction to Numerical Computations (2nd edition). Macmillan Publishing.
5. Kong, Q., Siauw T., Bayen A. (2020). Python Programming and Numerical Methods. Academic Press.