



Imperial College of Engineering

Affiliated to Tribhuvan University · Bhaktapur, Nepal

COURSE SYLLABUS HANDBOOK

Bachelor in Civil Engineering

BCE · Four years · Eight semesters

The official curriculum of the Institute of Engineering, Tribhuvan University, for students admitted in 2080 and later. Years I to III, 41 course syllabi.



BCE · 2080 CURRICULUM

About this handbook

This handbook brings every published syllabus for the Bachelor in Civil Engineering together in one place, arranged semester by semester, so that a student can see the whole degree from the first class to the last.

Each syllabus page is reproduced unchanged from the Institute of Engineering (IOE), Tribhuvan University. IOE writes and revises the curriculum and remains its authority. As a TU-affiliated college, Imperial College of Engineering teaches this same curriculum, and our students sit the same IOE examinations and receive the same Tribhuvan University degree as students on every other campus.

Years I to III are complete. IOE has named the Year IV courses but has not yet published their syllabi. They are listed on page 217 and will be added when IOE releases them.

DEGREE	Bachelor in Civil Engineering (BCE)
UNIVERSITY	Tribhuvan University, Institute of Engineering
CURRICULUM	2080 batch and later
DURATION	Four years, eight semesters
IN THIS BOOK	41 syllabi, Semesters 1 to 6
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YEAR I, PART I

Semester 1

7 COURSES IN THIS SEMESTER

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ENGINEERING MATHEMATICS I

ENSH 101

Lecture : 3
Tutorial : 2
Practical : 0

Year : I
Part : I

Course Objectives:

To equip the students with the essential mathematical skills and techniques that are relevant to the engineering fields and enable them to solve engineering problems using mathematical methods.

1 Derivatives and its Applications (10 hours)

- 1.1 Review of derivative and differentiability, mean value theorems with interpretations
- 1.2 Indeterminate forms, types and their real life examples, L-Hospital's rule
- 1.3 Power series of single valued functions
 - 1.3.1 Taylor's series
 - 1.3.2 Maclaurin's series
- 1.4 Asymptotes to Cartesian and Polar curves
- 1.5 Pedal equation to Cartesian and Polar curves
- 1.6 Curvature and radius of curvature for Cartesian curves

2 Antiderivatives and its Applications (11 hours)

- 2.1 Review of definite and indefinite integrals
- 2.2 Differentiation under integral sign
- 2.3 Improper integrals
- 2.4 Application of Beta and Gamma functions
- 2.5 Area, arc length, volume and surface of revolution in plane for Cartesian curves
- 2.6 Centroid and moment of inertia under area of curve

3 Ordinary Differential Equations and its Applications (10 hours)

- 3.1 Review of order, degree, solution of first order first degree differential equations by variable separation method and solution of homogeneous equations
- 3.2 Linear differential equation and equations reducible to linear differential equation of first order Bernoulli's equation, modeling electric circuit
- 3.3 First order and higher degree differential equations; Clairaut's form

- 3.4 Linear second order differential equations with constant coefficient and variable coefficients reducible to constant coefficients, Cauchy's equations and modeling mass spring system
- 3.5 Application in physical sciences and engineering

4 Plane Analytic Geometry (4 hours)

- 4.1 Transformation of coordinates: Translation and rotation
- 4.2 Equation of conic in Cartesian and Polar form, identification of conics

5 Three dimensional geometry (10 hours)

- 5.1 The straight line: Symmetrical and general form
- 5.2 Coplanar lines
- 5.3 Shortest distance
- 5.4 Sphere: General equation, plane section by planes, tangent planes
- 5.5 Introduction to right circular cone and right circular cylinder

Tutorials (30 hours)

- 1. Derivatives and its applications
- 2. Antiderivatives and its applications
- 3. Ordinary differential equations and its applications
- 4. Plane analytic geometry
- 5. Three dimensional geometry

Reference

- 1. Jeffery, A., (2001), Advanced Engineering Mathematics. Academic Press.
- 2. O'Neill, P.V., (2003), Advanced Engineering Mathematics. Thomson Learning.
- 3. Kreyszig, A. (1993), Advanced engineering Mathematics (Latest Edition). John Wiley & Sons.
- 4. Sastry, S.S. (2008), Engineering Mathematics Volume I and II. PHI India.
- 5. Wylie, C., Barrett, L. (1995), Advanced Engineering Mathematics (Latest Edition), McGraw-Hill College.
- 6. Thomas, T., Finny, R. (1984), Calculus and Analytic Geometry (Latest Edition.), Addison-Wesley.

ENGINEERING CHEMISTRY

ENSH 103

Lecture : 3
Tutorial : 1
Practical : 3

Year : I
Part : I

Course Objectives:

To develop the basic concepts of physical chemistry, inorganic chemistry, analytical chemistry, environmental chemistry, green & sustainable chemistry, nano chemistry, polymer chemistry and organic chemistry relevant to the different disciplines of engineering.

1 Electrochemistry and Buffer

(8 hours)

- 1.1 Electrochemistry
 - 1.1.1 Introduction
 - 1.1.2 EMF of galvanic cell, Nernst equation
 - 1.1.3 Polarization and overpotential
 - 1.1.4 Butler-Volmer equation and Tafel plots
- 1.2 Electrode processes and mechanisms
 - 1.2.1 Charge transfer processes at electrodes
 - 1.2.2 Mass transfer and diffusion in electrochemical systems
- 1.3 Industrial and applied electrochemistry
 - 1.3.1 Batteries: Lead acid and lithium ion
 - 1.3.2 Solar-photovoltaic cell, fuel cell
 - 1.3.3 Corrosion
- 1.4 Buffer, buffer range, buffer capacity and buffer solution and its applications

2 Catalyst and Catalysis

(4 hours)

- 2.1 Definition and types
- 2.2 Design and criteria
 - 2.2.1 Structure-activity relationships
 - 2.2.2 Selection criteria of catalyst
- 2.3 Photocatalysis and electrocatalysis
- 2.4 Catalysis for energy and environmental applications
 - 2.4.1 Catalytic conversion of fossil fuels
 - 2.4.2 Renewable energy catalysts
 - 2.4.3 Catalyst for pollution control

3 Analytical Techniques and their Applications (6 hours)

- 3.1 Chromatography
- 3.2 Mass spectroscopy
- 3.3 X-ray diffraction (XRD)
- 3.4 UV-visible spectroscopy
- 3.5 Infrared-spectroscopy (IR)
- 3.6 Nuclear magnetic resonance spectroscopy (NMR)

4 Metal Complexes, Rare Earth Elements and Metal alloys (6 hours)

- 4.1 Complexes
 - 4.1.1 Introduction and Werner's theory
 - 4.1.2 Geometry of complex by VBT and its applications
 - 4.1.3 Crystal field theory: Principle and applications
- 4.2 Rare earth elements: Introduction and applications
- 4.3 Metallic alloys and applications

5 Sustainable Chemistry (7 hours)

- 5.1 Green chemistry: Introduction and principles
- 5.2 Water chemistry
 - 5.2.1 Importance of water quality standards
 - 5.2.2 Degree of hardness, scale formation in boiler and softening of hard water
 - 5.2.3 Water pollution with reference to turbidity, COD, BOD, heavy metals, radioactive substances, and plastic
 - 5.2.4 Industrial wastewater and its treatment
- 5.3 Air pollution
 - 5.3.1 Particulate matter, SO_x, NO_x, GHGs, VOCs, their impacts and remedies
- 5.4 Waste management
 - 5.4.1 Segregation and management of solid waste
 - 5.4.2 Management of biodegradable waste into energy
 - 5.4.3 E-waste and its management

6 Nanoscience and Nanotechnology (3 hours)

- 6.1 Introduction and types of nano materials (0-, 1-, 2-, and 3- dimensional)
- 6.2 Nanoparticles, nanofibers, nanowires, carbon nanotubes, graphene, mxene, quantum dots, and their uses
- 6.3 Preparation of nanomaterials

7 Engineering Materials

(7 hours)

7.1 Polymers

- 7.1.1 Natural and synthetic, organic and inorganic, conducting and non-conducting
- 7.1.2 Types of polymerizations: Addition and condensation polymerization
- 7.1.3 Preparation and applications of epoxy resin, polyurethane, Kevlar, polycarbonate, polymethyl methacrylate, polyacrylonitrile, silicones; phosphorus based polymer, sulphur based polymer
- 7.1.4 Conducting polymers: Synthesis and application
- 7.1.5 Composite: Fiber reinforced polymer
- 7.1.6 Natural polymers: Cellulose, chitin, chitosan, collagen

7.2 Cement: Hydration and setting chemistry of cement

8 Explosives, Lubricants and Paints

(4 hours)

8.1 Explosives

- 8.1.1 Types of explosives: Primary, low and high explosives
- 8.1.2 Preparation and applications of TNT, TNG, Nitrocellulose and plastic explosives

8.2 Lubricants: Introduction, function and classification

8.3 Paints

- 8.3.1 Introduction, requisites, types and applications
- 8.3.2 Environmental and health impact

Tutorial

(15 hours)

Students will practice numerical problems covering all units and sub-units to strengthen conceptual understanding and problem-solving skills.

Practical

(45 hours)

1. Determination of total, temporary and permanent hardness of water sample using complexometric titration
2. Determination of the alkalinity of water sample A and B by double indicator titration
3. Estimation of the amount of residual chlorine in water by iodometric titration
4. Preparation of the standard buffer solution (Acidic or basic) and measure the approximate pH of given unknown solution by using Universal Indicator
5. Comparison of the cleansing power of two sample of detergents by determining the reduction they cause in surface tension of water
6. Construction of Daniell cell and study of the variation of cell potential with concentration
7. Separation of the pigments through the process of paper / thin layer chromatography
8. Determination of total iron in ground water using spectrophotometer technique

9. Determination of amount of copper and iron in a given mixture solution by $K_2Cr_2O_7$ titration
10. Preparation of cross – linked polymer by condensation polymerization method
11. Standardize potassium permanganate solution and use it to estimate the amount of Iron and determine the percentage purity in the sample of ferrous salt solution
12. Preparation of Ni-DMG complex and estimation of the amount of nickel

Reference

1. Maron, S. H., Prutton, C. F. (1965). Principles of Physical Chemistry (Latest Edition). Macmillan.
2. Lee, J.D. (2007). Concise Inorganic Chemistry. John Wiley & Sons.
3. Madan, R.D., Prakash, S. (1994). Inorganic Chemistry (Latest Edition). S. Chand & Company Ltd.
4. Bahl, S., Tuli, G.D., Bahl, A. (2009). Essentials of Physical Chemistry. S. Chand & Co. Ltd.
5. Bhagi, A. K., Morrison, G. R. T., Boyd, R. N. (2008). Organic Chemistry. Prentice-Hall of India.
6. Morrison, R. T., Boyd, R. N. (2008). Organic Chemistry. Prentice-Hall of India.
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8. Murthy, B. S., Shankar, P., Baldev, R., Rath, B. B., Murday, J. (2012). Textbook of nanoscience and nanotechnology. Universities Press.
9. Chatwal, G.R. (2023). Textbook of Environmental Chemistry. Himalaya Publishing House.

COMPUTER PROGRAMMING

ENCT 101

Lecture : 3

Tutorial : 1

Practical : 3

Year : I

Part : I

Course Objectives:

The primary goal of this course is to provide students with a solid foundation in the principles of programming and to impart practical skills in the C programming language. This course ensures that students comprehend the fundamental concepts of variables, data types, control structures, and functions within the context of C. Advanced topics such as pointers, structures, file handling and the standard C library are explored to broaden students' programming capabilities. Also, through project-based assessments and evaluations, students apply their knowledge to real-world scenarios, fostering creativity and project development skills.

1 Introduction to Computer Programming

(3 hours)

- 1.1 Definition of a computer program and programming language
- 1.2 Types and generations of programming languages
- 1.3 Problem-solving using a computer
 - 1.3.1 Problem analysis
 - 1.3.2 Algorithm and flowchart
 - 1.3.3 Programming
 - 1.3.4 Compilation, linking and execution
 - 1.3.5 Debugging and testing
 - 1.3.6 Documentation

2 Overview of C Programming

(3 hours)

- 2.1 Introduction to C programming
- 2.2 History and importance of C
- 2.3 C headers and library functions
- 2.4 Basic structure of a C program
- 2.5 Preprocessor directives
- 2.6 Tokens in C (Character set, keywords and identifiers)
- 2.7 Type casting (Implicit and explicit)
- 2.8 Data types, variables and constants
- 2.9 Compiler and IDE for C programming

3 Operators and Expressions (4 hours)

- 3.1 Introduction to operators and expressions
- 3.2 Arithmetic, relational and logical operators
- 3.3 Assignment, increment and decrement operators
- 3.4 Conditional, bitwise and special operators
- 3.5 Comma operator, size of operator
- 3.6 Evaluation and type conversion in expressions
- 3.7 Operator precedence and associativity

4 Input and Output (3 hours)

- 4.1 Introduction to data I/O in C
- 4.2 Unformatted I/O
 - 4.2.1 Character I/O
 - 4.2.2 String I/O
- 4.3 Formatted I/O
 - 4.3.1 Control string (Flags, field width, precision, and specifier)
 - 4.3.2 Formatted I/O (scanf(), printf())

5 Control Structures (8 hours)

- 5.1 Introduction to simple and compound statement
- 5.2 Sequential statement
- 5.3 Branching statement
 - 5.3.1 Simple if statement
 - 5.3.2 if-else statement
 - 5.3.3 Nested if-else statement
 - 5.3.4 else-if ladder
 - 5.3.5 switch statement
 - 5.3.6 go to statement
- 5.4 Looping statement
 - 5.4.1 for loop
 - 5.4.2 while loop
 - 5.4.3 do while
 - 5.4.4 Nested loop
- 5.5 Loop interruption
 - 5.5.1 break
 - 5.5.2 continue

6 Array and Pointer (7 hours)

- 6.1 Introduction to an array
- 6.2 One-dimensional array
- 6.3 Two-dimensional array

- 6.4 Multidimensional array
- 6.5 Introduction to string
- 6.6 String handling functions
- 6.7 Definition of a pointer
- 6.8 Pointer declaration
- 6.9 Pointer arithmetic
- 6.10 Relationship between pointer and arrays

7 User-defined Functions

(6 hours)

- 7.1 Introduction to function
- 7.2 Advantages of function
- 7.3 Elements of user-defined function
 - 7.3.1 Function definition
 - 7.3.2 Function prototype
 - 7.3.3 Function parameters
- 7.4 Storage class
- 7.5 Scope rules
- 7.6 Category of functions
 - 7.6.1 Functions with no arguments and no return values
 - 7.6.2 Functions with arguments and no return values
 - 7.6.3 Functions with arguments and return values
 - 7.6.4 Functions with no arguments and return values
- 7.7 Recursive functions
- 7.8 Function call by values and reference
- 7.9 Passing array and string to function

8 Structures

(5 hours)

- 8.1 Defining a structure
- 8.2 Declaring and accessing structure elements
- 8.3 Initializing structure
- 8.4 Array of structure
- 8.5 Array as member to structure
- 8.6 Pointer as member to structure
- 8.7 Structure as a member to structure
- 8.8 Passing and returning structures to/from function

9 File Management

(4 hours)

- 9.1 Introduction
- 9.2 Binary and text file in C
- 9.3 File opening modes
- 9.4 Defining, opening and closing file

- 9.5 Input-output operations on files
 - 9.5.1 Character I/O (fputc(), fgetc())
 - 9.5.2 String I/O (fgets(), fputs())
 - 9.5.3 Formatted I/O (fscanf(), fprintf())
 - 9.5.4 Record I/O (fwrite(), fread())
- 9.6 Overview of random file access
- 9.7 Error handling

10 Recent Trends in Programming

(2 hours)

- 10.1 Introduction to object oriented programming (OOP)
- 10.2 Definitions of class, method and object in OOP
- 10.3 Difference between procedure oriented and OOP
- 10.4 Overview of other high level programming languages

Practical

(45 hours)

- 1. Lab 1: Introduction and demonstrations of projects written in C
- 2. Lab 2: Formatted and unformatted Input/output in C
- 3. Lab 3: Branching in control structure
- 4. Lab 4: Looping in control structure
- 5. Lab 5: Array in C
- 6. Lab 6: String in C
- 7. Lab 7: Pointers in C
- 8. Lab 8: User defined functions in C
- 9. Lab 9: Structure in C
- 10. Lab 10: File handling in C
- 11. Group project on C maximum 4 students in a group at the end of the course.

Reference

- 1. Lafore, R. (1993). *The Waite Group's C programming using Turbo C++* (1st ed.). SAMS Publishing.
- 2. Balagurusamy, E. (2019). *Programming in ANSI C* (8th ed.). McGraw Hill Education.
- 3. Gottfried, B. S. (2010). *Programming with C* (3rd ed.). McGraw Hill Education.

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

ENEE 103

Lecture : 3
Tutorial : 1
Practical : 1.5

Year : I
Part : I

Course Objectives:

The course aims to provide a comprehensive understanding of electrical engineering basics, encompassing circuits, components, and related laws, emphasizing safety in installations. It also seeks to familiarize students with electrical machines, semiconductor devices, and initiate them into applications in digital electronics.

1 Fundamentals of Electrical and Electronics Circuits (12 hours)

- 1.1 Current and potential
- 1.2 Circuit components: Source, conductor, resistor, inductor, capacitor
- 1.3 Ohms law
- 1.4 Series and parallel circuits
- 1.5 Kirchhoff's law and its application
 - 1.5.1 Nodal analysis
 - 1.5.2 Mesh analysis
- 1.6 Introduction to AC circuits and parameters
 - 1.6.1 Generation of AC voltage
 - 1.6.2 Waveforms
 - 1.6.3 Average value
 - 1.6.4 RMS value
- 1.7 Single phase AC circuit analysis with R, RL, RC and RLC load
- 1.8 Three phase AC circuits
 - 1.8.1 Waveform and advantage
 - 1.8.2 Line and phase quantities in star and delta connection
 - 1.8.3 Voltage and current computation in balance circuits
 - 1.8.4 Power measurement in three-phase circuits

2 Electrical Machines (14 hours)

- 2.1 Faraday's law of electromagnetic induction
- 2.2 Dynamically and statically induced EMFs
- 2.3 Transformer
 - 2.3.1 Introduction of single-phase transformer
 - 2.3.2 Working principle of transformer
 - 2.3.3 Components of transformer
 - 2.3.4 Transformation ratio
 - 2.3.5 EMF equation of transformer

- 2.3.6 Types of transformers
- 2.3.7 Load and no-load operation
- 2.3.8 Ideal and practical transformer
- 2.3.9 Losses and efficiency
- 2.3.10 Applications
- 2.4 Three-phase induction motor
 - 2.4.1 Construction
 - 2.4.2 Rotating magnetic field
 - 2.4.3 Working principle
 - 2.4.4 Direction of rotor and slip
 - 2.4.5 Types of rotors
 - 2.4.6 Standstill and running condition
 - 2.4.7 Modes of operation
 - 2.4.8 Torque equations
 - 2.4.9 Torque-slip characteristics
 - 2.4.10 Applications
- 2.5 DC motors
 - 2.5.1 Construction
 - 2.5.2 Working principle
 - 2.5.3 Back EMF and its significance
 - 2.5.4 Power torque relationships
 - 2.5.5 Types of motors
 - 2.5.6 Losses and efficiency
 - 2.5.7 Applications
- 2.6 Synchronous generator
 - 2.6.1 Construction
 - 2.6.2 Working principle
 - 2.6.3 EMF equation
 - 2.6.4 Applications

3 Introduction to Electronics Engineering

(11 hours)

- 3.1 Semiconductor and doping
- 3.2 Introduction to diode
- 3.3 Characteristics of PN junction diode
- 3.4 Half-wave and full-wave rectifiers
- 3.5 Zener effect
- 3.6 Zener diode and its characteristics
- 3.7 Zener diode as a voltage regulator
- 3.8 Bipolar junction transistor
 - 3.8.1 Biasing
 - 3.8.2 BJT as a switch
 - 3.8.3 BJT as an amplifier
- 3.9 Introduction to digital electronics
- 3.10 Logic gates and Boolean algebra

4 Electrical Installations

(8 hours)

- 4.1 Consumer power supply system
- 4.2 Overview of electrical wiring components: Switches, sockets, and distribution boards
- 4.3 Protective devices, their constructions and sizing
 - 4.3.1 Fuse
 - 4.3.2 MCB
 - 4.3.3 MCCB
- 4.4 Wires and power cable
- 4.5 Types of wiring system
- 4.6 Determination of size of conductor
- 4.7 Earthing system and its importance
- 4.8 Electrical safety rules

Tutorial

(15 hours)

The tutorial sessions will focus on chapter-specific exercises aimed at enhancing understanding and application in electrical and electronics engineering

Practical

(22.5 hours)

- 1. Verification of Ohms law and Kirchhoff's law
- 2. Measurement of AC quantities using oscilloscope and study phase relation of RL and RC load
- 3. Measurement of line, phase and power in three-phase balanced load
- 4. Load test on single phase transformer and T-S characteristics of induction Machine
- 5. Connection of electrical installations of residential buildings
- 6. To study characteristics of PN and Zener diodes and perform half-wave and full-wave rectifiers

Reference

- 1. Mehta, V.K., Mehta, R. (2022). Principles of Electrical Engineering and Electronics. S. Chand Publishing.
- 2. Bhattacharya, S.K. (2017). Basic Electrical and Electronics Engineering I. Pearson Education India.
- 3. Bakshi, U.A., Bakshi, M.V. (2020). Electrical Technology. Technical Publications.
- 4. Floyd, T.L. (2021). Digital Fundamentals. Pearson Education India.
- 5. Neidle, M. (2016). Electrical Installation Technology. Elsevier.

ENGINEERING MECHANICS

ENCE 101

Lecture : 4
Tutorial : 2
Practical : 0

Year : I
Part : I

Course Objectives:

This course helps to analyze the effect of various types of forces on the particle and rigid body at rest and motion. It also provides concept and knowledge of engineering application and helps to understand structural engineering in later courses by using basics of mechanics in their branch of engineering.

1 Basic Concept of Mechanics and Static Equilibrium (5 hours)

- 1.1 Definitions, type and scope of mechanics
- 1.2 Fundamental concepts and principles of engineering mechanics
- 1.3 Concept of particle, rigid and deformed bodies
- 1.4 Physical meaning of equilibrium and its essence in structural application
- 1.5 Equation of equilibrium in 2D and 3D analysis of particle and rigid body
- 1.6 Concept of free body diagram with examples

2 Forces Acting on Particle and Rigid Body (9 hours)

- 2.1 Different types of forces: Internal/external force, adhesive/ cohesive force, point/ line/ surface force and contact/ body force
- 2.2 Resolution and composition of forces
- 2.3 Principle of transmissibility and equivalent forces
- 2.4 Varignon's theorem and its application
- 2.5 Moments of a force about a point and about an axis
- 2.6 Definition, types and characteristics of couple
- 2.7 Resolution of a force into a force and a couple
- 2.8 Resultant of force and moment for a system: Coplanar, concurrent and general force system
- 2.9 Concept and formation of wrench (Force and couple lying on a single plane)

3 Friction (4 hours)

- 3.1 Definition, types and uses of friction, laws of friction, static and dynamic coefficient of friction, angle of friction
- 3.2 Sliding and overturning condition of a body
- 3.3 Concept and working principle of jackscrew
- 3.4 Practical examples of dry friction (Ladder and Wedge friction)

4 Analysis of Simple Beams and Frames (10 hours)

- 4.1 Introduction to structures
- 4.2 Various types of load on the structure
- 4.3 Various types of supports; Reactions and degree of freedom
- 4.4 Internal and external forces in the structure
- 4.5 Relationship between load, shear force and bending moment
- 4.6 Statically and geometrically stable/ unstable beams and frames
- 4.7 Statically determinate and indeterminate beams and frames, degree of static indeterminacy
- 4.8 Axial force, shear force and bending moment diagrams for determinate beams and frames

5 Analysis of Plane Trusses (5 hours)

- 5.1 Definition of truss, assumption of ideal truss, types and uses of truss in engineering
- 5.2 Statically and geometrically stable and unstable truss
- 5.3 Statically determinate and indeterminate truss, degree of static indeterminacy
- 5.4 Analysis of truss by the method of joint and section/ moment

6 Centre of Gravity, Centroid, Moment of Inertia, and Mass Moment of Inertia (5 hours)

- 6.1 Concepts of centre of gravity and centroid of line, area and volume
- 6.2 Second moment of area/moment of inertia and radius of gyration
- 6.3 Perpendicular and parallel axis theorem for moment of inertia
- 6.4 Concept of mass moment of inertia

7 Kinematics of Particles (Rectilinear and Curvilinear Motion) (7 hours)

- 7.1 Position, velocity and acceleration of a particle for rectilinear motion
- 7.2 Dependent and relative motion of particles
- 7.3 Position, velocity and acceleration of a particle for curvilinear motion
- 7.4 Projectile motion
- 7.5 Tangential and normal components of velocity and acceleration
- 7.6 Radial and transverse components of velocity and acceleration

8 Kinetics of Particles: Force, Acceleration, Energy and Momentum (8 hours)

- 8.1 Newton's second law of motion, linear momentum and impulsive motion
- 8.2 Equation of motion and dynamic equilibrium
- 8.3 Angular momentum and rate of change of angular momentum
- 8.4 Equation of motion for rectilinear and curvilinear motion (Rectangular components, tangential and normal components and radial and transverse components) of particle
- 8.5 Work and energy principle
- 8.6 Principle of conservation of energy, concept of conservative and non-conservative system
- 8.7 Definition and types of impact

9 Kinematics and Kinetics of Rigid Body in Plane Motion, Energy and Momentum Methods (7 hours)

- 9.1 Translation, rotation and general plane motion
- 9.2 Absolute and relative velocity in plane motion
- 9.3 Instantaneous centre of rotation
- 9.4 Equation of motion: D'Alembert's principle
- 9.5 Angular momentum of rigid body
- 9.6 Principle of work and energy for a rigid body
- 9.7 Kinetic energy for a rigid body

Tutorials (30 hours)

- 1. Basic concept of mechanics and static equilibrium
- 2. Forces acting on particle and rigid body
- 3. Friction
- 4. Analysis of simple beams and frames
- 5. Analysis of plane trusses
- 6. Centre of gravity, centroid, moment of inertia and mass moment of inertia
- 7. Kinematics of particles (Rectilinear and curvilinear motion)
- 8. Kinetics of particles: Force, acceleration, energy and momentum
- 9. Kinematics and kinetics of rigid body in plane motion, energy and momentum methods

Reference

- 1. Beer, F. P., Johnston, E. R. (2019). *Vector Mechanics for Engineers: Statics and Dynamics* (12th ed.). McGraw-Hill Education.
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ENGINEERING GEOLOGY I

ENCE 102

Lecture : 2
Tutorial : 0
Practical : 1

Year : I

Part : I

Course Objectives:

The course will provide the basic knowledge of engineering geology to the civil engineering students. Students will be able to understand the fundamental of engineering geology and various natural process and their influence on the surface as well as sub-surface features, identification of rocks and their significance, enhance the knowledge of mountain building process and importance in the field of civil engineering.

1 Introduction to Engineering Geology (2 hours)

- 1.1 Introduction to geology, its branches, and their interrelationships
- 1.2 Definition of engineering geology and its importance in civil engineering
- 1.3 Importance of engineering geology in the context of Nepal

2 Structure of the Earth (3 hours)

- 2.1 Origin, and internal structure of earth
- 2.2 Plate tectonics and mountain building process
- 2.3 Geological time scale and evolution of life

3 Mineralogy and Petrology (7 hours)

- 3.1 Formation of minerals, crystal morphology, physical and chemical properties of minerals
- 3.2 Rock forming minerals and their engineering significance
- 3.3 Formation of rocks and their classifications
- 3.4 Introduction, classification, structure, texture, uses, engineering significance and field identification criteria of igneous rock, sedimentary rock, and metamorphic rock

4 Structural Geology (8 hours)

- 4.1 Introduction of geological plane and its orientation (Dip, Strike, Plunge, and Trend)
- 4.2 Study of different geological structures: Primary sedimentary structures (Bedding, lamination, cross-bedding, ripple marks, etc.) and secondary structures (Lineation, foliation, folds, joints, faults, and thrusts)
- 4.3 Field identification criteria of the different geological structure with their importance in civil engineering

5 Physical Geology (6 hours)

- 5.1 Introduction, definition, different geological agents (River, groundwater, glacier, wind, and sea water)
- 5.2 Weathering and erosion, different geomorphological features produced by geological agents
- 5.3 Volcanism

6 Geology of the Himalaya (4 hours)

- 6.1 Evolution of the Himalayas
- 6.2 Tectonic sub-division of the Himalaya (Indo-Gangetic Plain, Siwalik, Lesser Himalaya, Higher Himalaya, Tibetan-Tethys Himalayan zone) and physiographic sub-division of the Himalaya
- 6.3 Major discontinuities systems and their engineering significance and engineering geological problems in the different tectonic sub-division of the Himalaya

Practical (15 hours)

1. Identification of common rock forming minerals (Quartz, Feldspar, Muscovite, Biotite, Chlorite, Calcite, Dolomite, Tourmaline, Pyrite, Talc, Fluorite, Apatite, Corundum, Diamond, Kyanite, Sillimanite, Garnet and clay minerals)
2. Identification of rocks: Shale, Limestone, Sandstone, Siltstone, Conglomerate, Slate, Phyllite, Schist, Gneiss, Quartzite, Marble, Granite, Rhyolite, Gabbro, Basalt, Amphibolite, Syenite)
3. Study of different geological structures in the block diagram
4. Study of maps: Topographic and geological maps, construction of geological cross-section and their interpretation

Field works (2 days)

A two-day fieldwork to provide practical on-site knowledge on preparation and interpretation of engineering geological mapping (Measurement of geological plane using geological compass, identification of minerals and rocks, geomorphology, and geological structures, etc.). Students submit report after the fieldwork (**Attendance in Fieldwork is Compulsory**).

Reference

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CIVIL ENGINEERING MATERIALS

ENCE 103

Lecture : 2
Tutorial : 0
Practical : 1

Year : I
Part : I

Course Objectives:

To provide students an introductory knowledge about the wide range of materials used in the construction of engineering projects. This course emphasizes on the property, defects, productions, preservation, alternatives and utilities of various civil engineering materials which would help in selection of the suitable materials for construction projects. This helps to build a base for the selection, adequate consideration and precautions in aspect of materials during design and construction.

1 Basics of Civil Engineering Materials (2 hours)

- 1.1 Materials used in engineering constructions: Buildings; Road and bridges; Irrigation and hydropower; Water, gas and petroleum supply
- 1.2 Classification of materials on various basis: Existence in nature, functions or usage; Metallurgy; Composition of materials
- 1.3 Properties: Physical; Chemical; Mechanical; Thermal; Optical; Electrical; Magnetic
- 1.4 Failure of materials: Ductile and brittle failure
- 1.5 Factors affecting selection of materials: Properties and performance; Attributes and suitability; Durability, safety and requirements; Availability, reliability and disposability; and Economy and environment
- 1.6 Material and environment interactions: Corrosion; Weathering; Erosion; Thermal strain; Exposure to moisture, sunlight, and chemicals

2 Stones (3 hours)

- 2.1 Classification of rocks and aggregates: Geological, physical and chemical classifications of rocks; Introduction to coarse and fine aggregates
- 2.2 Properties of stones: Physical, chemical and mechanical properties
- 2.3 Characteristics of good stones: Appearance; Structure; Strength; Porosity and absorption; Weathering; Fire resistance; Hardness and toughness; Specific gravity; Thermal properties
- 2.4 Selection and use of stones: Selection criteria; Various uses of stones in engineering constructions
- 2.5 Deterioration and preservation of stones: Deterioration and its retardation; Preservation and preservatives used in stones
- 2.6 Production, storage and handling of stones: Natural bed of stones; Selection of quarry site; Methods of quarrying; Dressing of stones

3 Clay and Clay Products

(3 hours)

- 3.1 Clay: Use of clay in constructions; Classification/types of clays; Properties of clays
- 3.2 Brick earth: Constituents; Properties; Testing (Consistency test; Molding property test; Deformation and shrinkage test on burning; Strength and quality of brick test)
- 3.3 Bricks: Use of bricks; Manufacturing of local bricks; Classification and properties (Including mechanical properties) of bricks (Unburnt and burnt bricks); Characteristics of good bricks; Standard tests for bricks (Shape and size test; Colour test; Structure test; Soundness test; Hardness test; Water adsorption test; Efflorescence test; Compressive strength test)
- 3.4 Tiles: Use of tiles; Manufacturing process of tiles; Types and properties of tiles (Roof tiles, wall tiles, floor tiles, drain tiles); Characteristics of good tiles
- 3.5 Terracotta, earthenware and glazing: Properties; Use; Composition; Production
- 3.6 Storage and handling of clay and clay products

4 Lime

(2 hours)

- 4.1 Sources and constituent of limestones: Limestones and stone lime; Kankar lime; Shell lime; Magnesian lime; Impurities in limestones
- 4.2 Classification/types of limes: Quick lime; Flat lime, hydraulic lime, poor lime; Hydrated lime; Milk lime; Lump lime
- 4.3 Characteristics of lime, hydration of lime, slaking nature of lime, solidification of lime
- 4.4 Manufacture/production of lime: Flow diagram of lime production from limestone and kankar
- 4.5 Storage, handling and use of different types of lime
- 4.6 Types of pozzolanic materials and use with lime: Volcanic ash; Calcinated clay products; Clay/kaolin pozzolana; Mineral slag; Ashes of organic origin

5 Cement

(4 hours)

- 5.1 Fundamentals of cement: Ingredients of cement; Type and properties of cement; Storage, handling and use of cement; Characteristics of good cement
- 5.2 Classification of cements: Natural and artificial; Different types of cements, their composition, properties and applications (Ordinary Portland cement (OPC), rapid hardening cement, slow setting cement, Portland pozzolana cement (PPC), white cement, colored cement)
- 5.3 Manufacture of ordinary cement: Dry manufacturing process; Wet manufacturing process

- 5.4 Tests of cement: Field test; Laboratory tests (Fineness test, consistency test, initial and final setting time test, soundness test, compressive and tensile strength test)
 - 5.5 Cement clinkers: Compounds of cement clinkers and their functions in cement
 - 5.6 Hydration of cement and admixtures: Function and examples of admixture like water proofers, accelerators, retarders, plasticizers, air entraining agents
- 6 Mortar (2 hours)**
- 6.1 Function and use of mortar
 - 6.2 Properties of mortar: Workability, inertness, setting and hardening, adhesion
 - 6.3 Types of mortars: Classification (On the basis of binding materials, bulk density, nature of applications; Special mortars); Properties and use of different types of mortar
 - 6.4 Preparation, storage and handling of mortar: Hand mixing, machine mixing; Storage and handling of mortar
 - 6.5 Selection of mortar for different construction works: Selection criteria; Characteristics of a good mortar
 - 6.6 Testing of mortars: Crushing strength test, tensile strength test, adhesiveness test on building unit
- 7 Timber (3 hours)**
- 7.1 Tree and timber: Growth and structure of tree; Properties (Including mechanical) and use of timber; Defects in timber (During growth of trees, after felling of trees); Characteristics of good timber
 - 7.2 Classification of tree and properties of wood: Hard wood, soft wood
 - 7.3 Seasoning of timber: Definition and importance of seasoning; Types of seasoning (Natural and artificial seasoning)
 - 7.4 Deterioration and preservation of timber: Deterioration (Physical, chemical, biological); Types of preservatives; Methods of preservation
 - 7.5 Commercial product of timber: Veneers and ply wood; Boards (Laminated boards, fiber boards, block boards, and batten boards); Impreg and compreg timbers
 - 7.6 Bamboo: Properties (Including mechanical) of bamboo; Structural use of bamboo
- 8 Metals and Alloys (4 hours)**
- 8.1 Metals: Classification (Ferrous and nonferrous metals); Properties (Physical, chemical, mechanical, electrical, thermal, magnetic)
 - 8.2 Sources, composition, properties and uses of ferrous metals: Pig iron, cast iron, wrought iron, steel, alloys of steel

- 8.3 Sources, properties and uses of nonferrous metals: Aluminum, copper, lead, tin, zinc, magnesium, nickel
- 8.4 Heat treatment process and its importance in metals: Annealing, normalizing, quenching or hardening, tempering, surface hardening (Case hardening, nitriding, cyaniding, flame/ induction/laser hardening), defects in heat treatments
- 8.5 Commercial forms of metals and their uses: Sheets, channel sections (I, C, angle, tubular), bars
- 8.6 Corrosion and its prevention in steel: Theory of corrosion and its prevention with enameling; Applying metal coatings–Galvanizing, tin plating, electroplating; applying coatings – Painting and tarring

9 Paints and Varnishes

(3 hours)

- 9.1 Paints: Function and ingredients of paints; Characteristics of good paint
- 9.2 Type, composition, properties and uses of paints: Oil paints; Aluminum paints; Asbestos paints; Bituminous paints; Cellulose paints; Cement paints; Colloidal paints; Emulsion paints; Enamel paints; Graphite paints; Silicate paints; Anticorrosion paints; Plastic paints; Synthetic rubber paints; Distempers
- 9.3 Varnishes: Function and ingredients of varnishes; Characteristics of good varnishes
- 9.4 Type, composition, properties and uses of varnishes: Oil varnish; Turpentine varnish; Spirit varnish; Water varnish; Asphalt varnish; Spar varnish; Flat varnish
- 9.5 Process of application of different paints and varnishes: Application in new surfaces; Application in old surfaces
- 9.6 Defects in paints and varnishes: Effects of background (Dampness, cleanness, movement, reactions); Effects of weather (Blistering, peeling, checking, cracking, flaking, chalking, alligatoring, wrinkling, running and sagging, mildew, bloom, flashing, grining)

10 Miscellaneous Materials

(4 hours)

- 10.1 Asphalt: Origin, composition, properties, types and uses
- 10.2 Bitumen: Origin, composition, properties, types and uses
- 10.3 Tar: Origin, composition, properties, types and uses
- 10.4 Other materials: Composition, properties, types and uses of – Glass, plastic materials, rubber materials, insulating materials, gypsum products, adhesive and sealant materials, anti-termite treatment, water proofers, geosynthetics, carbon fiber
- 10.5 Composite materials: Composition, properties, types and uses of – Cement steel reinforced concrete, fiber reinforced plastics, glass fiber reinforced cement concrete or plastics, metal matrix composite

- 10.6 Emerging materials: Calcium silicate bricks; Concrete blocks; Aerated autoclave concrete blocks (AAC blocks); Interlocking compressed stabilized earth blocks (Interlocking CSEB), panels and boards

Assignments

1. Various ways to join timbers and metals
2. Commercially available other new materials used in constructions

Practical

(15 hours)

1. Water absorption test and bulk density, specific gravity test on brick sample
2. Compressive strength test of brick and stones
3. Consistency test of cement
4. Fineness and soundness test of cement
5. Setting time test of cement
6. Compressive strength of cement
7. Toughness test on steel and timber

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YEAR I, PART II

Semester 2

6 COURSES IN THIS SEMESTER

ENSH 151	Engineering Mathematics II	32
ENSH 152	Engineering Physics	35
ENME 158	Engineering Drawing	42
ENCE 151	Strength of Materials	46
ENCE 152	Engineering Geology II	50
ENCE 153	Engineering Survey I	53

2

ENGINEERING MATHEMATICS II

ENSH 151

Lecture : 3
Tutorial : 2
Practical : 0

Year : I
Part : II

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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6. Dutta, D. (2006). Textbook of engineering mathematics (Vols. I–II). New Age International.

ENGINEERING PHYSICS

ENSH 152

Lecture : 4
Tutorial : 1
Practical : 2

Year : I
Part : II

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 Fraunhofer's diffraction
 - 4.3.2 Fraunhofer'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.

References

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ENGINEERING DRAWING

ENME 158

Lecture : 2
Tutorial : 0
Practical : 4

Year : I
Part : II

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.

References

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.
2. French, T.E., Vierck, C.J., Foster, R.J. (1993). Engineering drawing and graphic technology (Latest Edition). McGraw-Hill.
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4. Bhatt, N.D. (2023). Elementary engineering drawing. Charotar Publishing House.
5. Gill, P.S. (2016). Engineering drawing. S. K. Kataria & Sons.
6. Dhawan, R.K. (2019). A textbook of engineering drawing. S. Chand and Company.
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STRENGTH OF MATERIALS

ENCE 151

Lecture : 3
Tutorial : 1
Practical : 2/2

Year : I
Part : II

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/permmissible 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-strain 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.
2. Gere, J. M., Timoshenko, S. P. (2002). Mechanics of materials (Latest Edition). Nelson Thornes.
3. Rajput, R. K. (2018). A textbook of strength of materials. S. Chand and Company.
4. Vavikatti, S.S. (2013). Strength of materials. Vikas Publishing House.
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6. Pytel, A., Singer, F.L. (1998). Strength of materials (Latest Edition). Harper Collins.
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8. Motra, G.B. (2021). A textbook of strength of materials. Heritage Publishers & Distributors.

ENGINEERING GEOLOGY II

ENCE 152

Lecture : 2
Tutorial : 0
Practical : 2/2

Year : I
Part : II

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).
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4. Hoek, E., Brown, E.T. (2019). The Hoek-Brown failure criterion and GSI-2018 edition. Journal of Rock Mechanics and Geotechnical Engineering.
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7. Krynine, D., Judd, W. R. (2005). Principles of Engineering Geology and Geotechnics. CBS Publishers.
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ENGINEERING SURVEY I

ENCE 153

Lecture : 3
Tutorial : 1
Practical : 4

Year : I
Part : II

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.
2. Punmia, B.C., Jain, A.Kr., Jain, A.K. (2005). SURVEYING VOL. I; VOL II & VOL III. Laxmi publication.
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YEAR II, PART I

Semester 3

7 COURSES IN THIS SEMESTER

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ENCE 201	Fluid Mechanics	65
ENCE 202	Theory of Structures I	69
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ENCE 205	Concrete Technology	79



ENGINEERING MATHEMATICS III

ENSH 201

Lecture : 3
Tutorial : 2
Practical : 0

Year : II
Part : I

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.

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NUMERICAL METHODS

ENSH 202

Lecture : 3
Tutorial : 1
Practical : 3

Year : II

Part : I

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., Siau T., Bayen A. (2020). Python Programming and Numerical Methods. Academic Press.

FLUID MECHANICS

ENCE 201

Lecture : 4
Tutorial : 2
Practical : 3/2

Year : I
Part : II

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.

THEORY OF STRUCTURES I

ENCE 202

Lecture : 3
Tutorial : 2
Practical : 2/2

Year : II
Part : I

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 frames 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 frames 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 Wiley & 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.

ENGINEERING SURVEY II

ENCE 203

Lecture : 3
Tutorial : 1
Practical : 4

Year : II
Part : I

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.

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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
Tutorial : 0
Practical : 3

Year : II
Part : I

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

CONCRETE TECHNOLOGY

ENCE 205

Lecture : 2
Tutorial : 0
Practical : 3/2

Year : II
Part : I

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 (22.5 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.



YEAR II, PART II

Semester 4

8 COURSES IN THIS SEMESTER

ENSH 251	Communication English	83
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ENCE 251	Hydraulics	89
ENCE 252	Theory of Structures II	94
ENCE 253	Soil Mechanics	98
ENCE 254	Water Supply Engineering	102
ENCE 255	Building Technology	108
ENCE 256	Survey Camp	111



COMMUNICATION ENGLISH

ENSH 251

Lecture : 3
Tutorial : 0
Practical : 1

Year : II
Part : II

Course Objectives:

The general objective of this course is to focus on English as a communication tool. Specifically, it emphasizes using English for professional communication for engineering works. It aims to increase English language ability to use appropriate research formats and methodology, develop concept papers, prepare research proposals and abstracts, set research questions, write a literature review, determine a research gap, link ideas, write technical proposals, prepare formal and informal reports and engage in project works, seminars/conferences.

- 1 Technical Communication (2 hours)**
 - 1.1 Definition, nature and scope of technical communication
 - 1.2 Professional ethics in communication (Ethical issues, plagiarism and copyright concerns, honesty, transparency and clarity)
- 2 Writing Skills (8 hours)**
 - 2.1 Principles of effective technical writing (Clarity, conciseness and coherence)
 - 2.2 Grammar (Pronoun and its antecedent, subject-verb agreement, non-finite verbs), sentence construction (Simple, compound, complex, and mixed sentences), error analysis and punctuation
 - 2.3 Bias-free language guideline, reducing bias
- 3 Technical Writing (15 hours)**
 - 3.1 Technical proposals (Purpose, types, structure, key considerations and examples)
 - 3.2 Research proposals and reports (Title page, table of contents, summary and abstract)
 - 3.3 Technical reports (Progress, feasibility and case study)
 - 3.4 Manuscript for journal (Structure, key considerations and examples)
 - 3.5 Citation and referencing (In-text citation, direct quote citations, indent citation, indirect citation, citing from books and journals, citing multiple authors in a single text, citing multiple texts from the same author, using numerical, pagination, preparing a reference page)

4 Business Correspondence (10 hours)

- 4.1 Writing formal letters (Applications, inquiries, complaints and orders)
- 4.2 E-mails (Structure, etiquette, and tone)
- 4.3 Notice, minutes and memos
- 4.4 Resume and cover letter
- 4.5 Press release/communique
- 4.6 Calling tender and responding to it

5 Listening and Oral Communication (4 hours)

- 5.1 Active listening (Barriers and strategies)
- 5.2 Effective speaking skills (Clarity, tone and pace)
- 5.3 Oral presentation skills (Structuring a presentation and handling questions)
- 5.4 Group discussions (Strategies and active participation)
- 5.5 Public speaking and speech delivery techniques

6 Use of Visual Aids in Communication (6 hours)

- 6.1 Tables
- 6.2 Graphs
- 6.3 Charts
- 6.4 Diagrams

Practical (15 hours)

- 1. Listening skill test
- 2. Visual skill test
- 3. Reading skill test
- 4. Oral communication test
- 5. Presentation skill test
- 6. Research proposals and project proposals
- 7. Team-based technical writing and presentations
- 8. Presentation on the prescribed texts
 - 8.1 "Which is More Important When Designing a Building: Beauty or Function?" from Unlock: Reading and Writing Skills by Chris Sowton
 - 8.2 On Being Modern-minded (Bertrand Russell)
 - 8.3 A Fable of Tomorrow" from The Silent Spring by Rachel Carson
 - 8.4 Religion and Science (From The World as I See It- Albert Einstein)
 - 8.5 "The Tamarisk Hunter" from Metatropolis by Paolo Bacigalupi
 - 8.6 Artificial Intelligence from The Art of Doing Science and Engineering by Richard W. Hamming
 - 8.7 Guglielmo Marconi and the History of Radio. Part II (Gerald A. Isted)
 - 8.8 Human-Centered Design (From The Design of Everyday Things- Don Norman)
 - 8.9 "The Paper Managerie" from The Paper Managerie and Other Stories by Ken Liu

8.10 "The Algorithm Will Save Us" from The New Voices of Fantasy by Sam J. Miller

8.11 "The Phantom Heart" by Laurence Yep

8.12 "Everyday Use" by Alice Walker

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	5
2	8	10
3	15	20
4	10	10
5	4	10
6	6	5
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Markel, M. and Selber, S. A. (2018). Technical communication (12th edition). Bedford/St. Martin's.
2. Ingre, D. (2017). Engineering communication: A practical guide to workplace communications for engineers (2nd edition). Cengage Learning.
3. Weisman, H. M. (2000). Technical communication for engineers: A handbook for engineers, scientists, and technicians. Prentice Hall.
4. Stevenson, S. and Whitmore, S. (2002). Strategies for engineering communication. John Wiley & Sons.
5. Rothwell, E. J., Cloud, M. J. (2017). Engineering writing by design: Creating formal documents of lasting value. CRC Press.
6. Blake, G., Bly, R. W. (1993). The elements of technical writing. Macmillan.
7. Beer, D., Mc Murrey, D. (2013). A guide to writing as an engineer (4th edition). John Wiley and Sons.
8. Farhathullah, T. M. (2002). Communication skills for technical students. Orient Longman.
9. Lebrun, J. L. (2007). Scientific writing: A reader and writer's guide. World Scientific Publishing.
10. Ligawa, H. (2021). Communication skills notes. Siaya Institute of Technology.
11. Katz, M. J. (2009). From research to manuscript: A guide to scientific writing (2nd edition). Springer.
12. Swales, J. M., Feak, C. B. (2012). Academic writing for graduate students: Essential tasks and skills (3rd edition). University of Michigan Press.
13. Hofmann, A. H. (2014). Scientific writing and communication: Papers, proposals, and presentations (2nd edition). Oxford University Press.

PROBABILITY AND STATISTICS

ENSH 253

Lecture : 3
Tutorial : 1
Practical : 0

Year : II
Part : II

Course Objectives:

The objective of this course is to equip students with foundational knowledge in probability and statistics, focusing on core concepts essential for engineering applications. Students will develop essential skills in statistical data analysis, enabling them to apply various statistical techniques to address real-world engineering challenges. Additionally, the course emphasizes the interpretation and effective communication of statistical results, preparing students to make informed, data-driven decisions in their professional practice.

- 1 Descriptive Statistics and Basic Probability (6 hours)**
 - 1.1 Introduction to statistics and its importance in engineering
 - 1.2 Measure of central tendency and measure of variation
 - 1.3 Graphical representation of data: Histograms, box plots and scatter plots
 - 1.4 Basic probability concepts, additive law, multiplicative law
 - 1.5 Conditional probability and Bayes' theorem
- 2 Probability Distributions and Sampling Distribution (14 hours)**
 - 2.1 Random variables: Discrete and continuous
 - 2.2 Expectation and variance of discrete and continuous random variables
 - 2.3 Discrete probability distributions: Binomial, Poisson, negative Binomial
 - 2.4 Continuous probability distributions: Normal, Gamma, Chi-Square
 - 2.5 Population and sample
 - 2.6 Sampling distribution of mean and proportion
 - 2.7 Central limit theorem
- 3 Statistical Inference (14 hours)**
 - 3.1 Point estimations and properties of estimators
 - 3.2 Confidence intervals for mean and proportions
 - 3.3 Hypothesis testing, parametric and non-parametric tests, procedure of hypothesis
 - 3.4 Hypothesis testing of mean (Single mean, two means, paired t-test and one-way)
 - 3.5 Goodness of fit tests and independence of attributes (Chi-square and Kolmogorov–Smirnov test)

4 Correlation and Regression (6 hours)

- 4.1 Correlation analysis and test of linear correlation
- 4.2 Simple regression analysis, the concept of explained, unexplained, and total
- 4.3 Multiple regression analysis

5 Statistical Quality Control (5 hours)

- 5.1 Quality control and its importance in engineering
- 5.2 Control charts for variables (X-bar, R-chart, P-chart)
- 5.3 Six sigma concepts

Tutorial (15 hours)

- 1. Visualize data, compute central tendency, and variance in engineering problems using computer software
- 2. Solve different engineering problems involving probability
- 3. Solve different engineering problems involving discrete probability distribution and its interpretation
- 4. Solve different engineering problems involving continuous probability distribution and its interpretation
- 5. Analyze numerical engineering datasets, perform normality tests, confidence intervals, significance tests of means, and ANOVA
- 6. Analyze categorical engineering datasets, perform crosstabulation, proportion tests, Chi-Square tests, and draw conclusions using computer software
- 7. Calculate the correlation coefficient and perform correlation tests on engineering data
- 8. Fit and interpret simple/multiple regression models on engineering data using computer software
- 9. Use control charts for process monitoring on sample engineering data.
- 10. Create control charts using computer software

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	10
2	14	15
3	14	20
4	6	10
5	5	5
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Ronald, E.W., Raymond, H.M., Sharon, L.M. (2012). Probability & Statistics for Engineers & Scientists (9th edition). Boston USA: Prentice Hall.
2. Richard A.J. (2018). Probability and Statistics for Engineers (9th edition). Edinburgh Gate: Pearson Education Limited
3. Sheldon M.R. (2009). Introduction to Probability and Statistics for Engineers and Scientists (4th edition). London: Elsevier Inc.
4. Jay L.D. (2012). Probability and Statistics for Engineering and Sciences. Boston: Thomson Brooks/Cole
5. Brian S.E., Ibrsten H. (2010). A Handbook of Statistical Analyses Using R (2nd edition). London: CRC Press Taylor & Francis Group
6. Andy F. (2018). Discovering Statistics Using IBM SPSS Statistics (5th edition). London: SAGE Publications.

HYDRAULICS

ENCE 251

Lecture : 4
Tutorial : 2
Practical : 2/2

Year : II
Part : I

Course Objectives:

The objective of this course is to provide knowledge of hydraulics to impart the concept of water resources engineering and their application in the field of civil engineering. It equips students the skills to analyze and solve fluid flow problems in closed conduits and open channels. It also aims to teach practical applications through laboratory experiments and software tools.

1 Pipe Flow Regimes (8 hours)

- 1.1 Concept, scope and importance of pipe flow
- 1.2 Reynolds experiment (Laminar, transition and turbulent flows)
- 1.3 Steady laminar flow in circular pipes (Shear stress, velocity distribution and head loss - Hagen Poiseuille law)
- 1.4 Examples and characteristics of turbulent flow
- 1.5 Shear stress in turbulent flow (Boussinesq's, Reynold's and Prandtl's mixing length theories)
- 1.6 Hydrodynamically smooth and rough boundaries; Velocity distribution for turbulent flow in pipes; Nikuradse's experiments
- 1.7 Darcy-Weisbach equation, friction factor for turbulent flow in smooth and rough pipes; Colebrook white equation, Moody chart, introduction to Hazen-Williams equation

2 Pipe Flow Problems (10 hours)

- 2.1 Minor head losses in pipes (Losses due to sudden enlargement, sudden contraction, entry, exit, obstruction, gradual contraction or enlargement, bends and fittings)
- 2.2 Hydraulic gradient line and total energy line
- 2.3 Pipes in series and parallel
- 2.4 Siphons (Working principle and applications)
- 2.5 Three reservoir problems
- 2.6 Pipe network problems (Hardy-Cross method)

3 Unsteady Flow in Pipes (6 hours)

- 3.1 Concept and equations of unsteady flow
- 3.2 Water hammer phenomenon and effects

- 3.3 Velocity and magnitude of pressure waves, equation for water hammer pressure (Gradual and rapid valve closures)
- 3.4 Pressure variation due to sudden closure of valve (With and without head loss)

4 Uniform Flow in Open Channels (8 hours)

- 4.1 Classification of open channel and geometric properties
- 4.2 Conditions for uniform flow (Expression for shear stress on the channel boundary)
- 4.3 Flow resistance equations (Chezy, Manning and Darcy-Weisbach equations and their relationships; Bazin and Kutter equations)
- 4.4 Manning's roughness coefficient (Determination and factors affecting roughness)
- 4.5 Velocity distribution and profiles (Velocity distribution in rectangular, triangular, trapezoidal, and circular channel sections; velocity distribution coefficients)
- 4.6 Best hydraulic channel sections (Dimensions for rectangular, triangular, trapezoidal and circular sections)
- 4.7 Uniform flow computation (Conveyance, section factor, normal depth)

5 Energy and Momentum Principles in Open Channel Flow (12 hours)

- 5.1 Introduction to non-uniform flow in open channel
- 5.2 Energy principle (Specific energy, specific energy curve, alternate depths, and criteria for critical flow)
- 5.3 Critical depth computations in prismatic channel sections (Rectangular, triangular, circular and trapezoidal sections)
- 5.4 Depth-discharge relationship
- 5.5 Application of energy principle (Channel with hump; transition with a change in width; choking; venturi flume; broad crested weir)
- 5.6 Momentum principle (Specific force; specific force curve; initial and sequent depths; conjugate depths; criteria for critical flow)
- 5.7 Application of momentum principle (Stilling basin; force on sluice gates; force on baffle blocks in stilling basin)

6 Rapidly Varied Flow in Open Channels (6 hours)

- 6.1 Characteristics of rapidly varied flow
- 6.2 Hydraulic jump (Analysis of hydraulic jump with assumptions)
- 6.3 Hydraulic jump in rectangular channel: Relationship between hydraulic jump variables (Conjugate depth, height of jump, efficiency of jump and length of the jump); energy loss in jump
- 6.4 Classification of hydraulic jump based on tail water level and Froude number

7 Gradually Varied Flow in Open Channels

(10 hours)

- 7.1 Characteristics of gradually varied flow
- 7.2 Analysis of gradually varied flow (Basic assumptions for analysis, dynamic equation, dynamic equation in wide rectangular channel and control section)
- 7.3 Channel bottom slope: Relation between water surface and channel bottom slopes; bottom slope characteristics (Mild, critical, steep, horizontal and adverse slopes)
- 7.4 Water surface profiles (Classification and characteristics of water surface profiles; practical examples of water surface profiles)
- 7.5 Computation of gradually varied flow in prismatic channels: Direct integration (Bresse method), direct step and standard step methods
- 7.6 Computation of location of hydraulic jump under different flow conditions

Tutorial

(30 hours)

1. Calculation of the Reynolds number and classify the flow regime (Laminar, transition, or turbulent) in a given pipe
2. Determination of the velocity distribution, shear stress, and head loss for steady laminar flow in circular pipes using the Hagen-Poiseuille equation
3. Computation of the head loss for turbulent flow in pipes using the Darcy-Weisbach equation and appropriate friction factors
4. Use the Colebrook-White equation and Moody chart to find the friction factor for turbulent flow in smooth and rough pipes
5. Calculation of the head loss due to a sudden contraction, enlargement, bends, fittings and, other minor losses in a pipe system
6. Solution for the total head loss in a system where pipes are arranged in series with varying diameters and lengths
7. Calculation of the flow distribution and head loss for pipes arranged in parallel
8. Analysis of the flow rate and pressure variations in a siphon, including head losses and practical applications
9. Calculation of the flow rates between three interconnected reservoirs using energy principles
10. Solution of flow rates and head losses in a given pipe network using Hardy-Cross method
11. Calculation of the pressure rise in a pipe due to sudden and gradual closure of a valve using the water hammer equation
12. Computation of the speed of pressure waves in pipes of different materials during transient flow conditions
13. Calculation of the flow velocity and discharge in open channels with given roughness coefficients using Manning's and Chezy's equations
14. Determination of the most efficient channel dimensions for rectangular, trapezoidal, and circular sections based on specific flow rates

15. Computation of the specific energy and critical depth in various channel shapes (Rectangular, trapezoidal, and triangular channels)
16. Solution of flow characteristics over a channel with a hump, transition with width change, through a Venturi flume and, broad-crested weir
17. Calculation of forces on sluice gates, baffle blocks, and stilling basins using the momentum principle
18. Determination of conjugate depths, energy loss, and jump efficiency for hydraulic jumps in rectangular channels
19. Calculation of the water surface profile for prismatic channels using direct integration, direct step and, standard step methods
20. Computation of the location of a hydraulic jump in an open channel under varying flow conditions

Assignment

Practical problem-solving for pipe flow and open channel flow using appropriate modeling tools.

Practical

(15 hours)

1. Reynolds' experiment
2. Head loss in pipes
3. Determination of Manning's coefficient for different surfaces
4. Flow through open sluice gates
5. Hump and constricted flow analysis
6. Hydraulic jump analysis

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

* There may be minor deviation in marks distribution.

References

1. Chow, V.T. (2009). Open-channel hydraulics. The Blackburn Press.
2. Chaudhry, M.H. (2014). Applied hydraulic transients (3rd edition). Springer.
3. Chaudhry, M.H. (2008). Open-channel flow (2nd edition). Springer.

4. Modi, P.N., Seth, S.M. (2022). Hydraulics and fluid mechanics including hydraulic machines (23rd edition). Standard Book House.
5. Kumar, K.L. (2021). Engineering fluid mechanics (9th edition) S. Chand Publishing.
6. Çengel, Y.A., Cimbala, J.M. (2022). Fluid mechanics: Fundamentals and applications (4th edition). McGraw-Hill Education
7. Crowe, C.T., Elger, D.F., Williams, B.C. (2021). Engineering fluid mechanics (11th edition). Wiley.
8. Larock, B.E., Jeppson, R.W., Watters, G. Z. (2014). Hydraulics of pipeline systems (2nd edition). CRC Press.
9. Sangroula, D.P., Bhattarai, P.K. (2017). A textbook of hydraulics: Fundamentals and applications (2nd edition). Green Books.

THEORY OF STRUCTURES II

ENCE 252

Lecture : 4
Tutorial : 2
Practical : 2/2

Year : II
Part : II

Course Objectives:

The course is designed to introduce key terminology and concepts related to displacements, stresses, strains, stiffness, and other parameters essential for understanding indeterminate systems. It provides practical examples to illustrate the fundamental concepts and theorems concerning static equilibrium, geometrical compatibility, and physical conditions such as forces, stiffness, and displacements within these systems. Additionally, the course equips students with the necessary skills for more advanced structural mechanics courses by introducing analytical tools, including the matrix method, force method, displacement method, and plastic analysis.

1 Introduction (4 hours)

- 1.1 Types of indeterminate structures
- 1.2 Boundary conditions and degree of freedoms
- 1.3 Static and kinematic indeterminacy
- 1.4 Structure idealization, local and global coordinate systems, deformations and their sign conventions
- 1.5 Determination of degree of static indeterminacy of a system: Use of formula, necessity of visual checking for plane systems in the form of beam, frame, truss and arch
- 1.6 Degree of kinematic indeterminacy of a system and its determination: Use of formula, necessity of visual checking for plane systems in the form of beam, frame, truss and arch
- 1.7 Definitions and explanations of force and displacement, flexibility and stiffness and their relationship

2 Theorem of Displacements (6 hours)

- 2.1 Force and displacements as cause and effects
- 2.2 Castigliano's theorems and their applications
- 2.3 Analyses of simple systems like beam, frame and truss
- 2.4 Bending moment, shear force and normal thrust diagrams for beam, truss and frames

3 Force Method (10 hours)

- 3.1 Definitions and explanations; Specialties of force method and its limitations
- 3.2 Consistent deformation systems; Compatibility equations, primary structures, choice of redundant
- 3.3 Flexibility method: Use in beam, frame and trusses; Yielding of supports in beam, truss and frames; Temperature effects and misfits in truss
- 3.4 Flexibility matrix method
- 3.5 Graph multiplication approach for simple cases
- 3.6 Three moment theorem and its application
- 3.7 Introduction to focal point method

4 Analysis of Indeterminate Arches (6 hours)

- 4.1 Use of arches in modern constructions
- 4.2 Horizontal reaction for parabolic and circular two-hinged and fixed arches
- 4.3 Bending moment, shear force and normal thrust diagrams
- 4.4 Yielding of supports, temperature effect and rib shortening
- 4.5 Influence line diagrams for horizontal thrust, bending moment at span, normal thrust and radial shear for two hinged arches

5 Slope Deflection Method (5 hours)

- 5.1 Introduction and sign conventions
- 5.2 Formulation of slope deflection equation
- 5.3 Fixed end moments
- 5.4 Application in beam and frames with support settlements and rotations
- 5.5 Bending moment, shear force and normal thrust diagrams for beam and frames

6 Moment Distribution Method (5 hours)

- 6.1 Introduction, terminology and development of method
- 6.2 Distribution factors
- 6.3 Carry over moments
- 6.4 Application in beam and frames: Symmetry and anti-symmetry, sway conditions and support yielding
- 6.5 Bending moment, shear force and normal thrust diagrams for beam and frames

7 Stiffness Matrix Method (12 hours)

- 7.1 Definition of stiffness, choice of redundant and degree of freedoms
- 7.2 Member stiffness matrix for spring, bar, truss and beam elements
- 7.3 Rotation matrices
- 7.4 Analysis of multiple spring connected systems, bar and string combinations, simple two-dimensional trusses

- 7.5 Applications to beams and two-dimensional frames, effects of settlement of support and temperature
- 7.6 Application in space/three-dimensional truss
- 7.7 Bending moment, shear force and normal thrust diagrams for beam and frames
- 7.8 Introduction to structural engineering related software

8 Influence Line for Indeterminate Beams (6 hours)

- 8.1 Necessity of influence line diagrams
- 8.2 Muller Breslau principle, its physical meaning and use
- 8.3 Influence line diagrams for reactions, bending moment and shear force in various sections of continuous beams (Two to three spans only)
- 8.4 Use of influence line diagrams to calculate reactions, shear forces and bending moments for concentrated force, couple and distributed load

9 Introduction to Plastic Analysis (6 hours)

- 9.1 Definitions and explanations
- 9.2 Plastic analysis of bending members
- 9.3 Plastic hinge and its length
- 9.4 Load factor, shape factor and plastic modulus
- 9.5 Basic theorems on methods of limit analysis
- 9.6 Collapse loads: partial collapse, complete collapse
- 9.7 Collapse with tied loads for simple cases of statically indeterminate beams (Not more than three spans) and frames (Only portal frames)

Tutorial (30 hours)

- 1. Theorem of displacements on computation of bending moment, shear force and normal thrust, truss and frames
- 2. Analysis of beam, frame and trusses using force method
- 3. Analysis of beam and frame using slope deflection method
- 4. Application of moment distribution method on analysis of beams and two-dimensional frames
- 5. Stiffness matrix method
- 6. Influence line for indeterminate beams
- 7. Plastic analysis of statically indeterminate beams and frames

Practical (15 hours)

Determination of redundant reaction components and their comparative studies in the following four experiments and three project works.

- 1 Continuous beams (propped cantilever, two spanned beams with various end conditions)
- 2 Two hinged arch
- 3 Symmetrical portal frame
- 4 Unsymmetrical portal frame

- 5 Analysis of two-dimensional truss of at least 4 degree of redundancy, solve by flexibility matrix method and calculate axial forces
- 6 Analysis of two-dimensional truss of at least 4 degree of redundancy, solve by stiffness matrix method and calculate axial forces
- 7 Analysis of two-dimensional frame of at least 4 degree of redundancy, solve by stiffness matrix method and draw bending moment diagram, shear force diagram and axial force diagram

Students should submit individual report of both lab test and project works

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

* There may be minor deviation in marks distribution.

References

1. Parajuli, H.R., Ojha, B. (2024). Structural Analysis -II, Indeterminate Structures. Kathmandu: Heritage Publishers & Distributors.
2. Darkov A. et al. (1979) Structural Mechanics, Mir Publishers, Moscow.
3. Ghali, A., Neville, A. M. (1989). Structural Analysis, A Unified Classical and Matrix Approach. Chapman and Hall.
4. Norris, C. H., Wilbur, J. B., Utku, S. (1991). Elementary Structural Analysis. McGraw-Hill International Editions, Civil Engineering Series.
5. Wang, C. K. (1983). Intermediate Structural Analysis. McGraw-Hill International Editions, Civil Engineering Series.
6. Joshi, H. R. (1991). Theory of Structure II - Course Manual. Katmandu : Institute of Engineering, Tribhuvan University.

SOIL MECHANICS

ENCE 253

Lecture : 4
Tutorial : 2
Practical : 2

Year : II
Part : II

Course Objectives:

The main objective of this course is to introduce the fundamental concepts of soil, including its index and engineering properties. Additionally, the course aims to provide knowledge of the mechanical behavior of soil under both static and dynamic loading conditions. By the end of the course, students will be able to quantify key soil properties and apply this knowledge to solve various soil engineering problems.

- 1 Introduction (6 hours)**
 - 1.1 Historical development of soil mechanics
 - 1.2 Scope and application of soil mechanics
 - 1.3 Soil formation and soil types
 - 1.4 Soil structures and clay minerals
- 2 Phase Relationship, Index Property and Soil Classification (12 hours)**
 - 2.1 Basic definitions
 - 2.2 Phase relationships: Volume-volume, mass-volume, weight-volume and mass-mass relationships
 - 2.3 Soil index properties: Index properties of coarse and fine grained soils
 - 2.4 Soil classification systems (MIT, USCS, IS, BS)
 - 2.5 Field identification of soil
- 3 Soil Water, Permeability and Seepage Analysis (8 Hours)**
 - 3.1 Soil water and capillarity
 - 3.2 Soil permeability (Darcy's law and its validity, coefficient of permeability from laboratory and field tests and their significance)
 - 3.3 Factors affecting soil permeability
 - 3.4 Permeability in stratified soil
 - 3.5 Two dimensional flow (Laplace equation)
 - 3.6 Flow net, flow net construction and applications
 - 3.7 Seepage through an earthen dam (with and without horizontal filter)
 - 3.8 Seepage through anisotropic soil condition
 - 3.9 Piping failure and its mitigation measures

- 4 Soil Stresses (8 hours)**
- 4.1 Effective stress principle
 - 4.2 Effective stress (Hydrostatic, one dimensional flow and uniform surcharge)
 - 4.3 Quick sand condition, problems and mitigation
 - 4.4 Stress due to applied load (Boussinesq's solution and its extension; Westergaard's solution)
 - 4.5 Newmark's influence chart
 - 4.6 Equivalent point load and approximate stress distribution for loaded areas
- 5 Consolidation (8 hours)**
- 5.1 Consolidation process (Spring analogy)
 - 5.2 One-dimensional consolidation theory
 - 5.3 Oedometer test (Compression, swelling and recompression indices; compressibility, volume change and consolidation coefficients; pre-consolidation pressure)
 - 5.4 Secondary consolidation
 - 5.5 Normally consolidated and over consolidated clay
 - 5.6 Settlement calculation
 - 5.7 Accelerating consolidation (Preloading, vertical and horizontal drains)
- 6 Shear Strength (12 hours)**
- 6.1 Shear strength, Mohr circle and Mohr-Coulomb failure theory
 - 6.2 Shear strength of soil
 - 6.2.1 Direct shear test
 - 6.2.2 Uniaxial compression test
 - 6.2.3 Triaxial compression tests (stress-strain behavior, stress path)
 - 6.2.4 Vane shear test
 - 6.3 Factors affecting shear strength
 - 6.4 Cyclic shear strength (Cyclic triaxial test, stress-strain behavior, hysteresis loop, shear modulus, cyclic strength envelope)
 - 6.5 Critical state framework
- 7 Soil Compaction (6 hours)**
- 7.1 Importance of soil compaction
 - 7.2 Compaction tests and results interpretation (Standard and modified Proctor tests, Harvard miniature compaction test)
 - 7.3 Factors affecting compaction
 - 7.4 Structure and engineering behavior of compacted soils
 - 7.5 Compaction specification and field control

Tutorials

(30 hours)

There shall be related tutorials exercised in class and given as regular homework exercise. Tutorial can be as following for each specified chapters

1. Computation of different soil parameters and their interrelationship (Phase relationships): Tutorial on calculating void ratio, porosity, water content, and degree of saturation; Examples demonstrating the relationship between bulk density, dry density, and unit weight
2. Index properties and soil classification: Tutorial on determining particle size distribution, Atterberg limits, and consistency indices; Soil classification exercises using the Unified Soil Classification System (USCS)
3. Problems Related to Soil Capillarity, Permeability, and Seepage: Exercises on computing capillary rise and pore water pressure; Solving problems related to Darcy's law for permeability; Tutorials on flow nets for seepage analysis in soil
4. Determination of Effective Stress for Different Conditions: Problems on effective stress computation for submerged soils and layered soils for different scenarios; Examples of vertical stress analysis under various applied loads
5. Computation from 1-D consolidation test and settlement calculations: Tutorial on interpreting laboratory consolidation test results; Exercises on calculating compression index, settlement, and rate of consolidation
6. Failure criterion and soil strength for different soils: Tutorials on Mohr-Coulomb failure criterion and shear strength parameters; Exercises on direct shear test, triaxial test (monotonic and cyclic), and undrained shear strength analysis
7. Problems on determining maximum dry density and optimum moisture content using standard Proctor test results

Practical

(30 hours)

1. Determination of moisture content and specific gravity
2. Determination of field density using core cutter and sand replacement method
3. Sieve analysis and hydrometer analysis
4. Determination of Liquid limit and Plastic limit
5. Permeability test using falling head and constant head
6. Oedometer test
7. Direct shear test on sand
8. Unconfined compression test on undisturbed sample
9. Triaxial test- unconsolidated undrained
10. Compaction test of natural soils

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	12	12
3	8	8
4	8	8
5	8	8
6	12	12
7	6	6
Total	60	60

* There may be minor deviation in marks distribution.

References

1. Terzaghi, K., Peck, R. B., Mesri, G. (1996). Soil mechanics in engineering practice. India: Wiley.
2. Craig, R. F. (2013). Soil Mechanics. Germany: Van Nostrand Reinhold.
3. Ranjan, G., Rao, A. S. R. (2011). Basic and Applied Soil Mechanics. India: New Age International (P) Limited.
4. Arora, K. R. (2008). Soil Mechanics and Foundation Engineering (geotechnical Engineering), 7/e. India: Standard Publishers.
5. Murthy, V. (2003). Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering. Switzerland: Taylor & Francis.
6. Das, B. M. (2002). Principles of geotechnical engineering. United Kingdom: Brooks Cole/Thompson Learning.
7. Bowles, J. E. (1978). Engineering Properties of Soils and their Measurement. United Kingdom: McGraw-Hill.

WATER SUPPLY ENGINEERING

ENCE 254

Lecture : 3
Tutorial : 2
Practical : 2/2

Year : II

Part : II

Course Objectives:

This course is designed to offer a comprehensive understanding of Water Supply Engineering. It covers fundamental theories, principles, design considerations, and practical knowledge in the field. Topics include various drinking water requirements and quantity estimation, sources and their selection, water examination (physical, chemical and biological) methods, quality requirements, engineering design of the conveyance networks, treatment plant components, reservoirs, distribution networks, construction, operation, and maintenance of water supply system. It also covers brief introduction to advanced water treatment methods. The course places strong emphasis on hands-on learning through examples and experiments, which are considered highly effective for helping students grasp and apply the course material.

1 Introduction (2 hours)

- 1.1 Importance of water, including water sanitation and hygiene (WASH) aspects
- 1.2 Historical development of water supply systems (Global to National context)
- 1.3 Pure and impure water; potable and wholesome water; polluted and contaminated water
- 1.4 Objectives and importance of water supply system
- 1.5 Types of water supply systems (Gravity, pumped, and combined); planning, typical components, and their functions
- 1.6 Schematic diagram of typical water supply systems

2 Sources of Water (4 hours)

- 2.1 Distribution of earth's water, water cycle (Hydrological cycle)
- 2.2 Climate change and water availability
- 2.3 Classification of water sources
 - 2.3.1 Surface water sources: Rivers, streams, lakes, ponds, and impounded reservoirs (capacity of reservoirs using mass curve and analytical methods)
 - 2.3.2 Groundwater sources (Confined aquifer and unconfined aquifer, springs, wells, infiltration galleries, sump wells), jack wells
 - 2.3.3 Alternative sources: Rainwater harvesting, reclaimed water sources
- 2.4 Yield of surface sources and wells (Practical approach)

- 2.5 Selection of sources: Technical and legal considerations
- 2.6 Conservation of drinking water sources

3 Quantity of Water (5 hours)

- 3.1 Water quantity estimation
 - 3.1.1 Per capita demand
 - 3.1.2 Design and base periods and selection criteria
 - 3.1.3 Demographic trends and forecasting (Arithmetical increase method, geometrical increase method, incremental increase method and decrease rate of growth method, zoning method, numerical on population forecasting)
- 3.2 Types of water demand (Domestic, livestock, commercial, public/municipal, Industrial, firefighting, loss/wastage, and total demand)
- 3.3 Variation in water demand, peak factors and its significances
- 3.4 Factors affecting water demand

4 Quality of Water (5 hours)

- 4.1 Types of impurities (Suspended, colloidal and dissolved) and their effects
- 4.2 Living organisms in water (Algae, bacteria, viruses, worms)
- 4.3 Water-related diseases (Water borne, water washed, water based, and water vector disease) causes and effects, their transmission routes, and preventive measures (Primary and secondary barriers)
- 4.4 Physical water qualities and their significance
 - 4.4.1 Solids (Suspended and dissolved)
 - 4.4.2 Turbidity
 - 4.4.3 Color
 - 4.4.4 Taste and odor
 - 4.4.5 Temperature
 - 4.4.6 Health, environment, and engineering significance
- 4.5 Chemical water qualities
 - 4.5.1 Chemistry of solutions: pH, solubility and pH dependence
 - 4.5.2 Hardness and alkalinity (Lime incrustation in pipeline and customer meter)
 - 4.5.3 Metals: Toxic and non-toxic metals
 - 4.5.4 Pollutants of emerging concerns
 - 4.5.5 Health, environment, and engineering significance
- 4.6 Biological water qualities
 - 4.6.1 Microorganisms in water and their classification (Oxygen requirement, temperature, disease-causing, life process, and shapes)

- 4.6.2 Health, environment, and engineering significance
- 4.6.3 Pathogen's indicators and their tests (Multiple tubes, membrane fermentation, and standard plate count method), the most probable number
- 4.7 Standard methods of water quality examination: US- Environmental Protection Agency (EPA), American Public Health Association (APHA) methods
- 4.8 Water quality standard for drinking purposes (World Health Organization and National)

5 Intakes

(3 hours)

- 5.1 Type of intakes and their components
- 5.2 Factors considered for site selection of an intake
- 5.3 Characteristics of intake (River intake, reservoir intake, spring intake, well intake)
- 5.4 Design considerations for intake

6 Water treatment

(14 hours)

- 6.1 Overview of drinking water treatment unit operation and process
- 6.2 Objectives of water treatment: Treatment processes and impurity removal
- 6.3 Physical treatment: Impurities removal and operation mechanism; design considerations
 - 6.3.1 Screenings: Types, head losses and design steps
 - 6.3.2 Plain sedimentation, principle, mechanism, and design: Theory of particle settlement; Derivative of Stoke's law, Hazen's law and Newton's law; Temperature effect on settling; Ideal sedimentation; Types of sedimentation tank; Design of sedimentation tank
 - 6.3.3 Filtration, operation mechanism, and design considerations: Theory of filtration, types of filters, slow and rapid sand filter, pressure filter and design consideration
 - 6.3.4 Aeration: Purpose, mechanism and methods
- 6.4 Chemical Treatment
 - 6.4.1 Coagulation and flocculation: Coagulation mechanism; coagulants (Types and their chemical reactions; Mixing devices (Purpose and types); flocculation tank and its design considerations; clarifiers; jar test
 - 6.4.2 Disinfection: Purposes and significance of disinfection; physical methods (boiling and UV); chemical methods (Halogens, ozone, potassium permanganate, silver); chlorination (theory, chlorine demand, dose, residual chlorine and contact time); Kinetics (Chick's law; types of chlorine (Hypochlorites, chloramines, liquid/ gas chlorine, and their usage); forms of chlorination (Plain chlorination, pre-chlorination, post-chlorination, double chlorination, multiple

- chlorination, breakpoint chlorination, super chlorination, de-chlorination); factors affecting efficiency of chlorination
- 6.4.3 Softening: Purposes; removal of temporary hardness (Boiling and lime treatment); removal of permanent hardness (Lime soda, Zeolite); demineralization and deionization process
- 6.5 Advanced water treatment processes (Brief introduction, impurities removal, and removal mechanism)
 - 6.5.1 Removal of heavy metals (Iron, Arsenic and Manganese)
 - 6.5.2 Removal of color, odor, and taste
 - 6.5.3 Advance oxidation processes (AOPs)
 - 6.5.4 Membrane filters (Ultrafiltration, nanofiltration, reverse osmosis)
 - 6.5.5 Desalination and electrodialysis
 - 6.5.6 Ozonation
 - 6.5.7 Adsorption: Activated carbon

7 Reservoirs and Distribution System (6 hours)

- 7.1 Water supply systems (Continuous and intermittent system)
- 7.2 Clear water reservoir
- 7.3 Service reservoir (Purpose, construction, types and design consideration)
- 7.4 Types of distribution system and layout (Tree, grid, ring and radial system)
- 7.5 Smart water distribution: Concept of district metering areas (DMAs) and supervisory control and data acquisition (SCADA)
- 7.6 Design of distribution system (Pipe hydraulics for branched and looped networks, design criteria and design steps)
- 7.7 Water supply systems for buildings (Hydraulic considerations)
- 7.8 Introduction to computer-aided design software: EPANET, WaterGems /WaterCADs, etc.

8 Conveyance of Water (2 hours)

- 8.1 Mode of conveyance: Open channel and pressure flow
- 8.2 Pipe materials
 - 8.2.1 Requirements of good pipe material
 - 8.2.2 Pipe corrosion: Corrosion mechanism and protection
 - 8.2.3 Types of pipe material (Cl, Gl, Steel, PE, HDPE, PVC, PPR, DI)
- 8.3 Pipe joints: Purposes and types (Socket, spigot, flanged, collar, screwed socket joints, butt and electrofusion joints for PE and HDPE pipes)
- 8.4 Laying of pipes: Construction, operation and maintenance considerations

9 Pipe Appurtenances, Operation and Maintenance (4 hours)

- 9.1 Valves: Purposes and types (Sluice, reflux, safety, air valves, pressure relieve valves, pressure sustaining valves, butterfly valves, gate valves, and drain valves); typical schematic diagram of a valve (With all accessories required)

- 9.2 Fittings: Purpose and types (Bends, reducers, tees, mechanical couplings, expansion joints, dismantling joints, stop cocks and water taps)
- 9.3 Flushing arrangements (Reservoirs, transmission mains, and at distribution lines)
- 9.4 Propose and construction of break pressure tank
- 9.5 Public stand post (Purposes, location, flows, and construction)
- 9.6 Pumps: Type of pumps, purpose and uses; layouts of pumps; introduction to pump curves
- 9.7 Operation of water supply system
- 9.8 Maintenance: Necessity, types (Regular, preventive and emergency maintenance)
- 9.9 Roles and responsibilities of different organizations in water supply management (Federal, provincial, local government, and user's committee)

Tutorial

(30 hours)

There shall be related tutorials exercised in class and given as regular homework exercise. Tutorial can be as following for each specified chapters

1. Computation of capacity of impounded reservoir by mass curve and analytical method, yield and safe yield calculation for surface and ground water sources
2. Population forecasting by arithmetical increase method, geometrical increase method, incremental increase method and decrease rate of growth method, zoning method.
3. Water demands calculation for a settlement/community
4. Solution on hardness and alkalinity and water quality related numerical problems
5. Intakes: Numerical on design of intake (spring)
6. Water Treatment: Numerical on design of sedimentation tank, determination of size and number of filters, numerical on chlorine demand, chlorine dose and residual chlorine, disinfectant concentration and contact time, killing concentration, working mechanism on advanced water treatment methods
7. Reservoirs and Distribution System: Determination of service reservoir capacity, pipe hydraulic, design criteria of distribution systems, and equivalent pipe method for looped networks, hydraulic calculation for multistorey building
8. Conveyance of Water: Preparation of pipe layout diagram for urban water supply
9. Pipe appurtenances, operation & maintenance, and computer-aided tools
10. Schematic diagram of valves and fittings, flushings and urban household plumbing from water meter to tap, water supply management and tools (Introducing some software and optimizing tools for water supply schemes)

Practical

1. Determination of temperature, color, turbidity and pH
2. Determination of suspended, dissolved and total solids

3. Determination of dissolved oxygen by modified Winkler method
4. Determination of optimum dose of coagulant by jar test apparatus
5. Determination of residual chlorine in water
6. Microbial analysis of water for fecal contamination

Assignment

1. A complete design of water supply schemes for a community (Quantity estimation, treatment and conveyance with necessary drawings using computer-aided design software)
2. A case study report on a conventional water treatment unit of running water supply scheme

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	3
2	4	5
3	5	7
4	5	7
5	3	4
6	14	18
7	6	8
8	2	3
9	4	5
Total	45	60

* There may be minor deviation in marks distribution.

References

1. American Public Health Association (APHA). (2017). Standard methods for the examination of water and wastewater (23rd ed.). APHA.
2. CPHEEO (1999). Manual on Water Supply and Treatment, Ministry of Housing and Urban Affairs, Government of India
3. Crittenden, J., Trussell, R.R., Hand, D.W., Howe, K.J., Tchobanoglous, G. (2005). Water Treatment Principles and Design, MWH, 2nd Edition, John Wiley & Sons Inc., USA.
4. Droste, R.L. (2014). Theory and Practice of Water and Wastewater Treatment, Wiley, New Delhi.
5. Mackenzie, D. (2010). Water and Wastewater Engineering—Design principles and practices. New York: McGraw-Hill.
6. DWSS – GON. (2021). Urban water supply and sanitation (sector) project, Design Guidelines, version 4. Project Management Office, Kathmandu.
7. Modi, P.N. (1998). Water Supply Engineering. Standard Book House, Delhi.

BUILDING TECHNOLOGY

ENCE 255

Lecture : 2
Tutorial : 2
Practical : 0

Year : II
Part : II

Course Objectives:

To introduce functional requirement of building, its component, special work, special treatment in building and sustainable building

- 1 Introduction (2 hours)**
 - 1.1 Built environment
 - 1.2 History of building technology and Nepalese buildings
 - 1.3 Classification of building based on occupancy, storey and height
 - 1.4 Loads on building
- 2 Functional Requirement of Building (5 hours)**
 - 2.1 Orientation and planning of building (factors and site selection)
 - 2.2 Lighting and thermal performance (daylight, artificial lighting, heat phenomena, thermal comfort and thermal performance)
 - 2.3 Ventilation and air conditioning (functional requirement, natural and mechanical ventilation, air conditioning)
 - 2.4 Sound and acoustic (characteristics, types, common defect)
- 3 Sub-structure and Superstructure Works (6 hours)**
 - 3.1 Sub-structure (Site exploration; foundation and its types; excavation of foundation on soft soil, hard rock, wetland and sloppy land; trenches for pipes and refilling works)
 - 3.2 Load bearing structure
 - 3.2.1 Stone masonry (Rubble and ashlar); composite, hollow block, autoclaved aerated cement block and compressed stabilized earthen block masonry; cavity wall; concrete 3D printing
 - 3.2.2 Wall finishes (Tools, methods and defects in plastering; pointing types; painting on wooden, metal and masonry surface)
 - 3.3 Frame Structure
 - 3.3.1 Reinforced cement concrete structure (Precast and cast-in-situ construction; formwork for wall, slab, staircase, beam and column; slip formwork; timbering for trenches; partition and parapet wall)

- 3.3.2 Steel Construction (Advantage and disadvantage, steel section, bolted and welded connection)
- 3.3.3 Joint types (expansion, construction and seismic); location and sealing of joint

4 Building Components and services (7 hours)

- 4.1 Doors and windows (Location, shape, size, terminology and fixing process; types based on shutter and working mechanism; ventilators)
- 4.2 Horizontal and vertical circulation (Corridors; ladder and its types; stair types and planning; lift and escalator; ramps)
- 4.3 Flooring (Solid and suspended floor; flooring types)
- 4.4 Roof (Terminology; types of pitched roof; roof covering)
- 4.5 Building services
 - 4.5.1 Plumbing (water distribution system, sanitary fittings, septic tank and soak pit)
 - 4.5.2 Electrification (wiring systems, lightening arrester and safety precaution)

5 Special Works on Building (7 hours)

- 5.1 Shoring, scaffolding and underpinning
- 5.2 Fire Protection (Fire resistant walls and columns, floors and roof, openings; fire extinguishing equipment)
- 5.3 Moisture movement, damp proofing methods and materials
- 5.4 Termite types and anti-termite treatment process
- 5.5 Thermal insulation (Insulating material; insulation of roofs, exposed walls, door and windows)
- 5.6 Sound insulation (Sound absorption and absorbents; insulating material; wall and floor insulation)
- 5.7 Seismic safety requirements (Building configuration; size and location of openings; earthquake resisting elements)
- 5.8 Repair and restrengthening (Structural and non-structural cracks; repair of cracks; retrofitting techniques for masonry and reinforced cement concrete structures)
- 5.9 Demolition of structures (steps before demolition and methods)

6 Sustainable Building (3 hours)

- 6.1 Concept and principles; rating system
- 6.2 Sustainable building construction methods (techniques and strategies)

Tutorial (30 hours)

There shall be related tutorials exercised in class and given as regular homework exercise. Tutorial can be as following for each specified chapters

1. Site plan, trench plan, floor plan and elevation
2. Foundation structure

3. Brick bonds (1 and 1-1/2 brick) and tools for masonry structures
4. Parapet wall and cavity wall detail
5. Timbering of trenches
6. Formwork and its components for slab, column beam and staircase
7. Detailing of door frames and shutters
8. Staircase plan, section and layout
9. Isometric view, plan and sections of lift and escalators
10. Isometric view, plan and section of scaffolding, shoring and underpinning
11. Pipe layout, septic tank and soak pit
12. Plumbing and electrical network
13. Case study on sustainable building

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	5	5
3	6	6
4	7	6
5	7	7
6	3	4
Total	30	30

* There may be minor deviation in marks distribution.

References

1. McKay, W. B., McKay, J. K. (1961). Building Construction. United Kingdom: Longmans.
2. Chudley, R., Greeno, R. (2016). Building Construction Handbook. United Kingdom: CRC Press.
3. Reid, E. (2013). Understanding Buildings a Multidisciplinary Approach. United Kingdom: CRC Press.
4. Punmia, B. C. (2008). Building Construction. India: Laxmi Publications Pvt Limited.
5. Kumar, S. (2006). Building Construction. India: Standard Publishers Distributors.
6. Kubba, S. (2012). Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes. Netherlands: Elsevier Science.
7. Kibert, C. J. (2016). Sustainable Construction: Green Building Design and Delivery. United Kingdom: Wiley.
8. Building Codes

SURVEY CAMP

ENCE 256

Duration: 10 days

Year: II

Part: II

Course Objectives:

The primary objective of the survey camp is to equip students with the practical experience and skills needed to apply their theoretical knowledge of Engineering Surveying in real-world conditions. Through hands-on fieldwork, students will gain exposure to various surveying methods, modern instruments, computational techniques, and best practices for presenting their findings in a professional report. By the end of the course, students will be able to effectively implement surveying techniques to address practical challenges in the field.

1 Establishment of Horizontal Control for Major Traverse (2 days)

- 1.1 Reconnaissance, stations selection and pegging of major traverse: Closed traverse at least 1.5 km perimeter (15-20 stations) controlled with reference to national grid system
- 1.2 Measurement of major traverse angles and distances by Total Station/DGPS
- 1.3 Level transfer using Auto level/DGPS
- 1.4 Computation of coordinates (NEZ)

2 Minor Traverse and Topographic Survey (5 days)

- 2.1 Reconnaissance, stations selection and pegging of minor traverse: Link traverse (5-7 stations) controlled with reference to major traverse
- 2.2 Measurement of minor traverse angles and distances by Total Station/DGPS
- 2.3 Level transfer using Auto level/DGPS
- 2.4 Computation of coordinates (NEZ)
- 2.5 Plotting of major and minor traverse
- 2.6 Detailed topographic survey from major and minor control points: Semi built up area around 4 to 6 hectares of land using Total Station/Drone
- 2.7 Digital data recording and plotting by CAD software

3 Bridge Site Survey (1.5 days)

- 3.1 Detailed topographic survey of suitable bridge site area (At least 200m x 120m)
- 3.2 Detailing by using total station; Vertical control for control points using auto level/DGPS
- 3.3 Preparation of topographic map, L-section and X-section to standard scale

4 Road Alignment Survey

(1.5 days)

- 4.1 Topographic survey of road alignment (Corridor at least 650m x 30m)
- 4.2 Preparation of topographic map of the corridor
- 4.3 Preparation of Plan, L-section and X-section (Right of Way 20 m) to standard scale including selection of grades and formation levels

Evaluation Criteria

Internal Assessment

(50 marks)

Attendance of 10 days weighted 10 marks but if anybody absent more than 3 days' camp should be repeated. Regular evaluation throughout the 10 days as well as viva for computation and plotting of major traverse, minor traverse, viva for road and bridge site survey and traverse orientation check should be taken

Final Exam

Standard reports shall be prepared group wise. During compilation of the report, data shall be submitted content wise and all the reference sketches and standard drawings shall be compiled in A3 size and all the original data and drawings shall be presented during final exam. In the final examination there will be viva and instrumentation as per following weightage.

The evaluation scheme will be as indicated in the table below:

Evaluation Method	Marks distribution*	Remarks
Viva / Report Presentation	30	
Instrumentation	20	Should pass individually
Total	50	

* There may be minor deviation in marks distribution.



YEAR III, PART I

Semester 5

7 COURSES IN THIS SEMESTER

ENCE 301	Design of Timber and Masonry Structures	114
ENCE 302	Foundation Engineering	117
ENCE 303	Design of Steel Structures	120
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DESIGN OF TIMBER AND MASONRY STRUCTURES

ENCE 301

Lecture : 3
Tutorial : 1
Practical : 0

Year : III
Part : I

Course Objectives:

The objective of the course is to develop conceptual and analytical skills for designing timber structures and masonry structures. The first part of the course deals with timber structures, where students will learn to design timber beams and columns, based on material properties and structural behavior. The second part deals with masonry structures, introducing students to classification, construction technologies and behavior of masonry structures.

1 Structural Timbers (2 hours)

- 1.1 Introduction to timber structures
- 1.2 Characteristics and classification of structural timbers
- 1.3 Factors affecting the strength of structural timbers
- 1.4 Grade of structural timbers and permissible stresses
- 1.5 Cross-laminated timber, glued-laminated timber, nail-laminated timber, and dowel-laminated timber

2 Joints in Timber Structures (4 hours)

- 2.1 Types of mechanical fasteners: Bolts, nails, screws
- 2.2 Behavior and design of bolted and nailed joints
- 2.3 Joint (Connection) detailing

3 Structural Elements of Timber Structures (8 hours)

- 3.1 Types of timber columns and columns bases
- 3.2 Design of axially loaded columns
- 3.3 Design of column subjected to combined bending and direct stresses
- 3.4 Types of timber beams
- 3.5 Design of flexural members (Beams and flitched beams)

4 Masonry Structures (4 hours)

- 4.1 Introduction, history and use of masonry structures
- 4.2 Characteristics of brick, stone, concrete block, hollow block, and compressed earth block

- 4.3 Stone masonry structures: Types and characteristics
- 4.4 Brick masonry structures: Types (English, Flemish and rat-trap bonds) and characteristics
- 4.5 Reinforced and un-reinforced masonry
- 4.6 Confined masonry

- 5 Design of Masonry Walls for Gravity Loads (8 hours)**
 - 5.1 Codal provisions
 - 5.2 Design of solid walls under gravity loads
 - 5.3 Design of walls with openings
 - 5.4 Design of walls subjected to eccentric loads
 - 5.5 Design of walls acting as columns

- 6 Masonry Structures Under Lateral Loads (7 hours)**
 - 6.1 In-plane and out-of-plane behavior of masonry structures
 - 6.2 Typical damage patterns in masonry structures due to lateral loads
 - 6.3 Ductile behavior of reinforced and unreinforced masonry structures
 - 6.4 Lateral force distribution for rigid and flexible diaphragms
 - 6.5 Design of masonry walls for wind loads
 - 6.6 Elements of lateral load-resisting masonry system

- 7 Seismic Design and Strengthening of Masonry Buildings (8 hours)**
 - 7.1 Seismic behavior of unreinforced and reinforced masonry
 - 7.2 Seismic design principles for masonry construction
 - 7.3 Seismic design of masonry walls: Axial load and bending
 - 7.4 Codal provisions for seismic design of masonry
 - 7.5 Seismic strengthening measures of masonry structures

- 8 Testing of Masonry Elements (4 hours)**
 - 8.1 Compressive strength of bricks and walls
 - 8.2 Diagonal shear test
 - 8.3 Non-destructive tests: Ultra-sonic pulse velocity test; Elastic wave tomography; Semi-destructive tests (Flat-jack test, push shear test)

- Tutorial (15 hours)**
 - 1. Connection detailing of timber joints
 - 2. Design of different types of timber columns
 - 3. Design of different types of timber beams
 - 4. Design of solid wall under gravity loads
 - 5. Design of solid wall with piers
 - 6. Design of wall with openings under gravity loads
 - 7. Design of walls subjected to eccentric loadings

8. Design of walls acting as columns
9. Design of masonry walls subjected to wind loads
10. Design of shear wall under seismic loads

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

* There may be minor deviation in marks distribution.

References

1. Arya, A. S. (1992). Masonry and timber structures including earthquake resistant design (Latest Edition). Nem Chand & Bros.
2. Dayaratnam, P. (2017). Brick and reinforced brick structures. Oxford & IBH Publishing.
3. Handry, A. W., Sinha, B. P., Davies, S. R. (1981). An introduction to load bearing brick design (Latest Edition). University of Edinburgh.
4. Drysdale, R. G., Hamid, A. A., Baker, L. R. (1999). Masonry structures: Behaviour and design (Latest Edition). Prentice Hall.
5. Tomazevic, M. (1999). Earthquake-resistant design of masonry buildings (Latest Edition). Imperial College Press.

FOUNDATION ENGINEERING

ENCE 302

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : I

Course Objectives:

The objective of this course is to provide a comprehensive understanding of the geotechnical investigation and analysis of structures commonly encountered in civil engineering practice. It focuses on the stability analysis of slopes, analysis of flexible and rigid retaining structures, and analysis of shallow and deep foundations under various ground conditions.

- 1 Geotechnical Investigation (8 hours)**
 - 1.1 Geotechnical investigation; Objective and scope
 - 1.2 Stages and extent of site exploration
 - 1.3 Methods of site exploration: Accessible, inaccessible and indirect methods
 - 1.4 Soil sampling (Disturbed and undisturbed) and samplers
 - 1.5 Field tests (Standard penetration test, static cone penetration test, dynamic cone penetration test, pressure meter tests and dilatometer test)
 - 1.6 Ground water observation and borehole logs
 - 1.7 Geophysical tests and their application
 - 1.8 Evaluation of liquefaction potential
- 2 Slope Stability Analysis (4 hours)**
 - 2.1 Types of slopes and possible failures
 - 2.2 Analysis of infinite slopes
 - 2.3 Analysis of finite slopes ($\phi_u=0$, friction circle, method of slices)
 - 2.4 Use of stability charts
- 3 Earth Pressure Theories (5 hours)**
 - 3.1 Earth pressure and slope retaining structures
 - 3.2 Wall movement and types of earth pressure
 - 3.3 Rankine earth pressure theory
 - 3.4 Coulomb earth pressure theory
 - 3.5 Culmann's graphical solution
- 4 Bearing Capacity Theories (4 hours)**
 - 4.1 Basic terminologies and their relationships
 - 4.2 Types of shear failure

- 4.3 History and development of bearing capacity theories
- 4.4 Terzaghi's bearing capacity theory
- 4.5 Corrections on Terzaghi's bearing capacity equation
- 4.6 Skempton, Meyerhof, Brinch Hansen and Vesic's methods

5 Analysis of Shallow Foundation (7 hours)

- 5.1 Shallow foundation and its types
- 5.2 Settlement of foundation, its types and effects
- 5.3 Allowable bearing capacity of strip and isolated footings
 - 5.3.1 Bearing capacity from in-situ tests and laboratory test results
 - 5.3.2 Safe bearing pressure
- 5.4 Raft foundation and its types
- 5.5 Bearing capacity of raft foundation
- 5.6 Stress distribution and settlement of raft foundation
- 5.7 Foundation on stratified soil

6 Analysis of Deep Foundation (6 hours)

- 6.1 Deep foundations: Pile, pier and caisson and their classification
- 6.2 Load carrying capacity of single pile (Static, in-situ tests, dynamic and pile load test) and group action of pile
- 6.3 Settlement of pile foundation
- 6.4 Lateral and uplift capacity of pile
- 6.5 Construction and quality assurance of pile foundation
- 6.6 Negative skin friction
- 6.7 Analysis of pier foundation
- 6.8 Components of well (Caisson) foundation
- 6.9 Lateral stability of well foundation
- 6.10 Sinking of well, problems and remedial measures

7 Analysis of Foundation in Rock (3 hours)

- 7.1 Basis for design of foundation on rock
- 7.2 Foundations on weathered and un-weathered rock
- 7.3 Bearing capacity and settlement of foundation
- 7.4 Treatment of rock defects

8 Retaining Structures: Rigid and Flexible (8 hours)

- 8.1 Types of rigid and flexible retaining structures and their application
- 8.2 Proportioning and stability analysis of rigid retaining wall
- 8.3 Theory of arching
- 8.4 Flexible retaining structures (Type and function)
- 8.5 Analysis of sheet piles

- 8.6 Analysis of braced excavation
- 8.7 Analysis of reinforced or mechanically stabilized earth wall

Tutorial (30 hours)

1. Sampler requirement, correction of standard penetration values, correlations of penetration results, liquefaction potential evaluation
2. Analysis of finite and infinite slopes
3. Calculation of earth pressures using Rankine and Coulomb's theories
4. Bearing Capacity analysis of shallow foundation
5. Bearing capacity analysis of deep foundation
6. Bearing capacity analysis of foundation in rock
7. Analysis and design of flexible retaining structures

Practical (15 hours)

1. Video presentation of drilling methods
2. Drilling by any one method
3. Standard penetration test
4. Sample collection and laboratory tests

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	4	6
3	5	8
4	4	6
5	7	8
6	6	10
7	3	4
8	8	10
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Das, B. M. (2020). Principles of Geotechnical Engineering. Cengage Learning.
2. Arora, K. R. (2019). Soil Mechanics and Foundation Engineering (Geotechnical Engineering). India: Standard Publishers.
3. Murthy, V. (2003). Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering. Switzerland: Taylor & Francis.
4. Bowles, J. E. (1978). Engineering properties of soils and their measurement (Latest Edition). United Kingdom: McGraw-Hill.

DESIGN OF STEEL STRUCTURES

ENCE 303

Lecture : 3
Tutorial : 1
Practical : 0

Year : III
Part : I

Course Objectives:

The objective of this course is to introduce the behavior and design of steel structural members, focusing on their response to various loads. It covers key failure modes and design principles. At the end of the course students will be able to apply theoretical knowledge and skill to solve problems on complex steel structures.

1 Introduction (4 hours)

- 1.1 Steel structure: Scope; advantages and disadvantages; types of steel structures
- 1.2 Structural steel and classification of steel sections
- 1.3 Design process and basis for design
- 1.4 Method of analysis and design
 - 1.4.1 Working stress method
 - 1.4.2 Limit state design method: Different limit states for steel design; Design strength of materials and design loads
 - 1.4.3 Ultimate load method
- 1.5 Prevailing codes and standards

2 Connections in Steel Structures (13 hours)

- 2.1 Connection in steel structure: Importance and its type
- 2.2 Welded connections: Welds and welding; Design of simple and eccentric welded connections
- 2.3 Bolted connections: Bolts and bolting; Design of simple and eccentric bolted connections
- 2.4 Riveted connections: Brief introduction

3 Tension Members (4 hours)

- 3.1 Tension members: Definition and type of tension members
- 3.2 Sectional area of tension members
- 3.3 Design of tension members of simple and built-Up section
- 3.4 Design of lug angle and tension splices

4 Flexure members (10 hours)

- 4.1 Steel beams and its type
- 4.2 Design of simple beam and built-up beams
- 4.3 Design of continuous beams
- 4.4 Design of plate girders
 - 4.4.1 Necessity and requirements of plate girders
 - 4.4.2 Design for bending, shear, deflection and lateral stability
 - 4.4.3 Curtailment of plates
 - 4.4.4 Design of web and flanged splices

5 Compression Members (10 hours)

- 5.1 Types of compression members
- 5.2 Buckling behavior of columns
- 5.3 Design of column of simple and built-up sections
- 5.4 Design of lateral bracing of compression members
- 5.5 Design of eccentrically loaded columns
- 5.6 Design of column bases
 - 5.6.1 Axially loaded column bases
 - 5.6.2 Eccentrically loaded column bases
- 5.7 Design of column splices

6 Design of Roof Trusses (4 hours)

- 6.1 Types and components of roof trusses
- 6.2 Loads on roof trusses
- 6.3 Wind load calculations
- 6.4 Design of roof components

Tutorial (15 hours)

- 1. Design of bolted connections
- 2. Design of welded connection
- 3. Analysis and design of tension members
- 4. Analysis and design of flexure members
- 5. Analysis and design of web-splice and stiffeners of plate girder
- 6. Analysis and design of compression members
- 7. Wind load calculations
- 8. Design of purlins

Course Project

- 1. A Course project on integrated design of a building/industrial structure or just a member using computer aided design (CAD)
- 2. A 3D model of a particular portion of a steel structure using papers and cardboards

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	4	4
2	13	15
3	4	6
4	10	14
5	10	15
6	4	6
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Duggal, S. K. (2010). Limit state design of steel structures. Tata McGraw-Hill Education.
2. Ram, S. (2010). Design of steel structures. Pearson Education India.
3. Ramamrutham, S. (1986). Design of Steel Structures (6th ed.). Dhanpat Rai Pub Company.
4. Subramanian, N. (2011). Steel structures: Design and Practice. Oxford University Press, USA.
5. Bhavikatti, S. (2009). Design of steel structures (By limit State method as per IS: 800 2007). I. K. International Pvt Ltd.
6. Suwal, R. (2015). Design of Steel Structure (By Limit State Method) (Reprint 2017). Mark Line Publication, Kathmandu.

TRANSPORTATION ENGINEERING I

ENCE 304

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : I

Course Objectives:

This course provides civil engineering students with foundational knowledge in transportation system components, planning, and engineering. Upon completion, students will be able to choose highway alignments, design highway geometrics, understand highway drainage components, and identify material requirements for highway construction.

1 Transportation System, Planning and Engineering (10 hours)

- 1.1 Transportation system
 - 1.1.1 Definition, scope and role of transportation
 - 1.1.2 Components and characteristics of transportation system
 - 1.1.3 Transportation system classification
 - 1.1.4 Modes of transportation
 - 1.1.5 Comparison of different modes of transportation
- 1.2 Transportation planning
 - 1.2.1 Need of transportation planning
 - 1.2.2 Classification and system approach in transportation planning
 - 1.2.3 Multimodal transportation planning
 - 1.2.4 Transportation planning and land use transportation model
- 1.3 Transportation engineering
 - 1.3.1 Scope of transportation engineering
 - 1.3.2 Highway engineering
 - 1.3.3 Airport engineering
 - 1.3.4 Railway engineering
- 1.4 Traffic engineering
 - 1.4.1 Definition and scope of traffic engineering
 - 1.4.2 Road user and vehicular characteristics
 - 1.4.3 Perception reaction process, skid resistance and brake efficiency
 - 1.4.4 Stopping sight distance and overtaking sight distance

2 Highway Engineering (4 hours)

- 2.1 Highway engineering and scope
- 2.2 Advantages of road transportation
- 2.3 History of road development
- 2.4 Classification of roads in Nepal (NRS, NRRS, NURS)

- 2.5 Highway alignment
 - 2.5.1 Requirements of ideal alignment
 - 2.5.2 Factors controlling highway alignment
 - 2.5.3 Engineering survey for highway alignment
 - 2.5.4 Special consideration in hill road alignment

3 Geometric Design of Highway (16 hours)

- 3.1 Factors controlling geometric design of highway
- 3.2 Design of cross-sectional elements of highway
 - 3.2.1 Typical cross section of highways, urban roads and hill roads
 - 3.2.2 Design of camber, super elevation and extra widening
- 3.3 Design of horizontal alignment: Tangents; Curves including transition curves; Hair pin bends; Setback requirement considering sight distance
- 3.4 Design of vertical alignment: Gradient; Grade compensation; Vertical curve
- 3.5 Combination of horizontal and vertical alignment, safety in road design

4 Highway Drainage (4 hours)

- 4.1 Highway drainage and its importance
- 4.2 Requirements of highway drainage
- 4.3 Causes of moisture variation in subgrade soil
- 4.4 Classification of highway drainage: Surface drainage; Subsurface drainage; Cross drainage
- 4.5 Erosion control and energy dissipation measures in highway drainage structures along with special drainage structures in hill roads

5 Highway Materials (11 hours)

- 5.1 Introduction and classification of highway materials
- 5.2 Subgrade soil: Desirable properties; CBR test
- 5.3 Road aggregates: Desirable properties; Lab tests; Gradation analysis
- 5.4 Bituminous binders: Introduction, types and lab tests
- 5.5 Bituminous mixes: Definition and types; Bituminous concrete mix design

Tutorial (30 hours)

- 1. Alignment selection in contour map and geometric design with preparation of plan, profile and cross section of at least 500 m long road section (Students will work in a group of 6 and prepare a report and presentation)
- 2. Design of camber, super elevation and extra widening
- 3. Design/calculation of different components of horizontal curves including transition curves
- 4. Calculation of stopping sight distance and overtaking sight distance
- 5. Design of vertical curves
- 6. Gradation analysis
- 7. Bituminous mix design (Marshall mix design)

8. Video presentations (Geometric elements/drainage components/hairpin bends)

Practical

(15 hours)

1. Standard CBR test
2. LA abrasion, crushing, impact, elongation and flakiness index tests
3. Softening point, viscosity, penetration and ductility tests on bitumen
4. Gradation analysis of aggregate
5. Determination of optimum binder content by Marshall mix design method (Density void analysis and Marshall stability test)
6. Bitumen extraction 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	10	12
2	4	6
3	16	20
4	4	8
5	11	14
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Sharma, S. K. (2014). Principles, Practice and Design of Highway Engineering (4th Edition). S. Chand & Company Ltd.
2. Khanna, S. K., Justo, C. E. G. (2021). Highway Engineering (Revised 10th ed.). Nem Chand & Bros.
3. Flaherty, C. A. (2002). Highway Engineering. Edward Arnold Publishers Ltd.
4. Department of Roads, Ministry of Physical Infrastructure and Transport. (2013). Nepal Road Standard 2070. Government of Nepal.
5. Ministry of Urban Development. (2019). Nepal Urban Road Standard 2076. Government of Nepal.
6. Ministry of Federal Affairs and Local Development. (2014). Nepal Rural Road Standards (2055, 2nd rev. 2071). Government of Nepal.
7. Shrestha, D. K., Marsani, A. (2020). Transportation Engineering II (4th Edition). Heritage Publisher and Distributors.
8. Khanna, S. K., Justo, C. E. G., Veeraragavan, A. (2013). Highway Materials and Pavement Testing. Nem Chand & Bros.

SANITARY ENGINEERING

ENCE 305

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : I

Course Objectives:

The objective of this course is to provide a comprehensive knowledge of sanitary and wastewater engineering and management. It covers basic theories, principles, designs, and practical knowledge in these fields. Topics include sources and quantity of wastewater, methods of wastewater examination (physical, chemical, and biological), wastewater microbiology, disposal techniques, design of sewers, treatment plant components, sludge management and wastewater treatment methods. The course is focused to hands-on learning through examples and lab experiments, which are considered highly effective for students to grasp and apply the course material.

1 Introduction (2 hours)

- 1.1 Sanitary engineering: Environment, water sanitation, and hygiene aspects
- 1.2 Objective of wastewater treatment, disposal, and management
- 1.3 Definitions: Sewage/wastewater; Domestic sewage; Industrial sewage; Sanitary sewage; Storm water; Sullage; Sewer; Black water; Brown water; Yellow water; Grey water; Sewerage; Garbage; Rubbish; Solid waste
- 1.4 Historical development and importance of wastewater management (Global to national context)
- 1.5 Sanitation systems (Conservancy and water carriage systems) with merits and demerits
- 1.6 Sewerage systems and types (Separate, combined and partially separate systems) with merits, demerits, and engineering significance
- 1.7 Typical schematic diagram of wastewater, and solid waste management methods: Collection, conveyance, treatment, and disposal

2 Quantity of Wastewater (4 hours)

- 2.1 Dry weather flow and wet weather flow
- 2.2 Sources of sanitary sewage: Private and public; Groundwater infiltration; Unauthorized connections
- 2.3 Factors affecting the quantity of sanitary sewage: Population; Rate of water supply; Groundwater infiltration; Unauthorized connections
- 2.4 Quantity estimate of sanitary sewage: Variations; Peak factor; Peak flow
- 2.5 Quantity estimate of storm water: Rational and empirical formulae, time area graph and their limitations; Empirical formula for rainfall intensities
- 2.6 Factors affecting the quantity of storm water
- 2.7 Design discharge of wastewater for separate, combined and partially separate systems

3 Design and Construction of Sewers

(4 hours)

- 3.1 Sewer and its function (Open and closed channel flow)
- 3.2 Shapes of sewers: Circular and non-Circular sections (Merits and demerits)
- 3.3 Sewer materials: Requirements; Types (Salt glazed stoneware, cement concrete, cast iron, vitrified clay, wooden, PVC, CPVC, HDPE)
- 3.4 Design criteria of sewers
 - 3.4.1 Specific gravity of wastewater
 - 3.4.2 Design period and selection criteria
 - 3.4.3 Minimum and maximum velocities; Self-cleansing velocity
 - 3.4.4 Sewer size and gradient range
 - 3.4.5 Hydraulic design of sewers by Manning's, Chezy's and Hazen Williams formulae
 - 3.4.6 Hydraulic elements of sewers for partial flow condition
 - 3.4.7 Partial flow diagrams and its significance
 - 3.4.8 Design of sewers of separate and combined systems
- 3.5 Introduction to storm water drainage system
- 3.6 Construction of sewer: Desk study; Setting out; Alignment and gradient; Excavation of trench; Timbering of trench; Dewatering of trench; Laying and jointing; Testing of sewer (Straightness, obstruction, water and air tests) Backfilling of trench; Maintenance

4 Sewer Appurtenances

(3 hours)

- 4.1 Necessity of sewer appurtenances
- 4.2 Introduction, importance, use, construction, and working mechanism of sewer appurtenances: Manhole; Drop manhole; Lamp hole; Street inlets; Catch basin; Flushing devices; Sand, grease and oil traps; Inverted siphon; Sewer outlet; Ventilating shaft; Wastewater / storm water regulators

5 Wastewater Microbiology

(4 hours)

- 5.1 Microbes of interest and their roles in wastewater: Bacteria; Fungi; Algae; Protozoa; Rotifers; Crustaceans
- 5.2 Types of microorganisms in wastewater: Based on carbon source, energy, and environmental factors (Oxygen requirement, pH, salt, temperature)
- 5.3 Requirement for microbial growth: Nutrient; Electron donor; Acceptor; Macronutrients and micronutrients; Environmental conditions
- 5.4 Bacterial growth and biomass yield: Bacterial reproduction; Population dynamics; Growth curve and kinetics; Metabolism process (Anabolism and catabolism); Waste removal mechanism
- 5.5 Decomposition of wastewater and type of bacteria: Aerobic; Anoxic; Facultative; Anaerobic decomposition with process microbiology
- 5.6 Fates of carbon, nitrogen, phosphorous in wastewater
- 5.7 Fresh and stale wastewater: Microbiological aspects

6 Characteristics and Examination of Wastewater

(5 hours)

- 6.1 Introduction and importance of characteristics of wastewater
 - 6.1.1 Physical characteristics and their significance: Colour; Odour; Temperature; Turbidity
 - 6.1.2 Chemical characteristics and their significance: PH; Solids; Carbonaceous nitrogenous: Phosphorous contents
 - 6.1.3 Biological characteristics and their significance: Bacteria (Total and Feecal coliform)
- 6.2 Sampling of wastewater
 - 6.2.1 Grab, composite, and integrated samples
 - 6.2.2 Preservation, storing and transportation
- 6.3 Biochemical oxygen demand (BOD)
 - 6.3.1 Definition of BOD and its significance
 - 6.3.2 BOD in term of population equivalent
 - 6.3.3 Derivation of BOD equation
 - 6.3.4 Rate reaction, ultimate BOD and relation with temperature
 - 6.3.5 Relative stability
- 6.4 Chemical oxygen demand (COD): Definition, types and significance
- 6.5 Examination of wastewater
 - 6.5.1 Necessity of wastewater examination (Forms of phosphorous and nitrogen, solid fractionation, fractionation of total organic carbon)
 - 6.5.2 Examination of wastewater: Suspended; Volatile; Fixed and total solids; Settleable and non-settleable solids; Dissolved oxygen (DO); Theoretical oxygen demand (TOD); BOD with and without dilution; COD; Total organic carbon (TOC); Total and Kjeldahl nitrogen; Total phosphorous

7 Wastewater Disposal

(5 hours)

- 7.1 Necessity and objectives of wastewater disposal
- 7.2 National effluent discharge standards and provisions
- 7.3 Wastewater disposal methods: Dilution and Land treatment
 - 7.3.1 Wastewater disposal by dilution process and essential conditions for dilution: Self-purification of rivers/streams; Factors affecting self-purification (Dilution, current, sunlight, sedimentation, temperature, oxidation and reduction); Oxygen sag curve; Streeter Phelp's equation (Derivation not required)
 - 7.3.2 Wastewater disposal by land treatment: suitability of land treatment; Methods of land treatment (Irrigation, overland flow, rapid infiltration, broad irrigation and sewage farming); Methods of application of sewage on land (Flooding, surface irrigation, ridge and furrow method, subsurface irrigation, and spray irrigation); Sewage sickness and its prevention

8 Wastewater Treatment

(12 hours)

- 8.1 Treatment processes and impurities removal
- 8.2 Treatment train/process flow diagram
- 8.3 Physical treatment processes
 - 8.3.1 Racks and Screens: Purpose, types and construction (Bar, coarse, and fine screens); design criteria
 - 8.3.2 Grit chamber: Purpose, construction and design criteria
 - 8.3.3 Skimming tank: Purpose, construction, and design criteria
 - 8.3.4 Equalization tank: Introduction, purposes, and types
 - 8.3.5 Sedimentation tank: Principle of settling (Type I, II, III, and IV), purpose, types, and design criteria
- 8.4 Chemical treatment process: Chemical precipitation (Purpose, mixing, and flocculation)
- 8.5 Biological (Secondary) treatment process
 - 8.5.1 Objectives of biological treatment process
 - 8.5.2 Principles of biological treatment process (Attached and suspended growth processes)
 - 8.5.3 Types of biological treatment process
 - 8.5.3.1 Sewage filtration, filter types: Intermittent sand filter (Purpose, construction, working, cleaning, merits and demerits); Contact bed (Purpose, construction, working, cleaning, merits and demerits); Trickling filter (Purpose, construction, working, cleaning merits and demerits, types - high and standard rates, recirculation, two-stage filters, design criteria, operational and maintenance issues)
 - 8.5.3.2 Activated sludge process: Principle, construction and process description; Aeration methods (Design parameters and criteria, secondary clarifier, advantages and disadvantages); Sludge volume/density index and its significance; Control parameters and operational issues (Filamentous bulking, Foaming and mousse formation, Pin-point floc, deflocculation)
 - 8.5.3.3 Oxidation ponds: Purpose, merits and demerits of oxidation ponds; theory of oxidation ponds; construction of oxidation ponds; commissioning; operation and maintenance; operational issues; design criteria
- 8.6 Sequential batch reactor, membrane bioreactor and moving bed bioreactor: Introduction, removal mechanism and application
- 8.7 Tertiary treatment system: Mechanism, impurity removal and application
 - 8.7.1 Pathogen removal: Disinfection, disc filters, and maturation ponds
 - 8.7.2 Nutrient removal (Nitrogen and phosphorous): Decentralized wastewater treatment system (Introduction, Mechanism, and uses); Anaerobic baffled reactor; Nature-based treatment system - Constructed wetland (Types based on flow: Surface and subsurface, Horizontal and vertical flow), advantages and disadvantages

9 Sludge Treatment and Disposal

(3 hours)

- 9.1 Sources and characteristics of sludge
- 9.2 Estimation of sludge volume; Volume-Moisture relation
- 9.3 Sludge treatment methods
 - 9.3.1 Grinding and blending
 - 9.3.2 Thickening: Gravity thickener (Purpose, construction and loading criteria)
 - 9.3.3 Digestion: Aerobic and anaerobic digestion, digestion process, control of digestion, construction and design criteria of digester
 - 9.3.4 Drying: Sludge drying beds (Purpose and construction)
 - 9.3.5 Sludge disposal methods: Dumping; Landfilling; Lagoons; Spreading on land; Composting (Purpose, principles, types - Windrow and mechanical); Incineration (Purpose and construction)
- 9.4 Faecal sludge management practices (Treatment train): Issues, and challenges in Nepal

10 Onsite Sanitation of Waste from Isolated Facilities

(3 hours)

- 10.1 On site sanitation: Definition, necessity, and types
- 10.2 Solid Waste Management: Definition, necessity, 3R principles, composting and types
- 10.3 Pit privy: Purpose and construction; Ventilated improved pit latrine (VIP) - Purpose, construction, design criteria, types (Single pit, double pits and multiple pits, advantages and disadvantages)
- 10.4 Pour flush latrine: Purpose, construction, and design criteria
- 10.5 Septic tank: Purpose, construction, design criteria, working and maintenance
- 10.6 Septic tank effluent disposal methods: Drain field (Purpose, construction, and design criteria); Soak pit (Purpose, construction, and design criteria); Evapotranspiration mound (Purpose and construction); Leaching cesspool (Purpose and construction)
- 10.7 Design of VIP latrine, pour flush latrine, septic tank, drain field, and soak pit

Tutorial

(30 hours)

- 1. Preparation of typical schematic diagrams of wastewater, solid waste treatment and management
- 2. Estimation of sanitary sewage, storm water and wastewater for separate, combined and partially separate systems
- 3. Design of sewers for separate and combined systems, design criteria of sewers, partial flow conditions in sewers
- 4. Preparation of schematic diagrams of various sewer appurtenances
- 5. Preparation of bacterial growth curve, biomass calculation, degradation steps for carbon and nitrogen
- 6. Numerical on solids, BOD, and forms of carbon and nitrogen on BOD test

7. Streeter-Phelp's equation, Numerical on purification of rivers/streams, and requirements of degree of treatment
8. Numerical on screening, grit chamber, sedimentation tank, trickling filter, activated sludge process, and oxidation pond, preparation of treatment trains
9. Numerical on sludge volume determination, Volume-Moisture relation and design of digesters, schematic diagram of type of digesters
10. Design of VIP latrine, pour flush latrine, septic tank, drain field, and soak pit, sanitary calculation and drawing of an urban household
11. Numerical on bar screens, grit chamber, and sedimentation tank
12. Numerical on oxidation ponds and activated sludge process

Practical

(15 hours)

1. Determination of suspended, dissolved, volatile and total solids
2. Determination of biochemical oxygen demand
3. Determination of chemical oxygen demand
4. Determination of sludge volume index, MLSS, and MLVSS
5. Determination of ammonia/nitrate and phosphate
6. Video presentation or observation of wastewater treatment plant

Assignment

Design of community wastewater treatment system or faecal sludge treatment plant (Quantity estimation, treatment system and sludge disposal). A treatment train system can be modelled and designed using free tools such as WRC STOAT.

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	3
2	4	5
3	4	5
4	3	3
5	4	6
6	5	6
7	5	6
8	12	17
9	3	5
10	3	4
Total	45	60

* There may be minor deviation in marks distribution.

Reference

1. American Public Health Association (APHA). (2017). Standard methods for the examination of water and wastewater (23rd Edition). APHA.
2. DWSS – GON. (2021). Urban water supply and sanitation (sector) project, design guidelines (Version 4). Project Management Office, Panipokhari, Kathmandu.
3. Metcalf & Eddy. (2014). Wastewater Engineering: Treatment and Resource Recovery (5th Edition). McGraw-Hill.
4. CPHEEO. (2013). Manual on sewerage and sewage treatment systems. Ministry of Housing and Urban Affairs, Government of India.
5. Davis, M. (2010). Water and wastewater engineering: Design principles and practices. McGraw-Hill.
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7. Metz, D., Modi, P.N. (2020). Sewage treatment & disposal and wastewater engineering. Standard Book House.
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ENGINEERING HYDROLOGY

ENCE 306

Lecture : 3
Tutorial : 2
Practical : 2/2

Year : III
Part : I

Course Objectives:

The objective of this course is to provide students the concept of hydrology and meteorology with computational analysis for the design and management of water resources projects using practical approach on the application of hydro-meteorological knowledge to solve engineering problems. After completion of this course students will be able to estimate precipitation, hydrological losses and runoff from a watershed, measure the streamflow and analyze hydrographs, floods and flood routing.

1 Introduction (3 hours)

- 1.1 Scope and application of engineering hydrology
- 1.2 Hydrologic cycle and water balance equations
- 1.3 Development of hydro-meteorological study and data in Nepal
- 1.4 Delineation of hydrological boundary and its characterization

2 Precipitation (8 hours)

- 2.1 Causes, forms and types of precipitation
- 2.2 Rainstorm hydrology
 - 2.2.1 Rainfall Measurement: Types, network and adequacy of rain-gauges
 - 2.2.2 Preparation of rainfall data: Estimation of missing rainfall data; Test for consistency of record by double mass curve
 - 2.2.3 Presentation of rainfall data: Mass curve; Hyetograph; Point rainfall; Moving average annual rainfall graph
 - 2.2.4 Cumulative distribution and probability density functions of rainfall
 - 2.2.5 Mean rainfall over an area: Arithmetic mean, Thiessen and Isohyets
 - 2.2.6 Depth duration (DD), depth area duration (DAD) and intensity duration frequency (IDF) curves
 - 2.2.7 Frequency of rainfall; Goodness of fit test (Chi square test)
 - 2.2.8 Probable maximum precipitation (PMP)
- 2.3 Snowstorm hydrology
 - 2.3.1 Snow climatology, snow distribution and snowpack condition
 - 2.3.2 Snowfall measurement: Snow depth, snow stakes and snow boards
 - 2.3.3 Water equivalent of snow: Snow density; snow gauges and tubes
 - 2.3.4 Remote sensing of snowpack; Ultrasonic snow depth sensor
 - 2.3.5 Snow-melting runoff process; Snowmelt-runoff modeling
 - 2.3.6 Changing snowpack and glaciers in a warming world
 - 2.3.7 Snow avalanches

- 3 Abstractions from Precipitation (Hydrological Losses) (6 hours)**
- 3.1 Initial losses: Interception and depression storage
 - 3.2 Evaporation
 - 3.2.1 Meteorological parameters: Radiation, temperature, vapor pressure, humidity and wind speed
 - 3.2.2 Measurement of evaporation by Evaporimeters
 - 3.2.3 Empirical evaporation equations: Meyer's and Rohwer's formulae
 - 3.2.4 Evaporation estimation by water-budget and energy-budget methods
 - 3.3 Evapotranspiration
 - 3.3.1 Actual evapotranspiration and measurement by Lysimeters
 - 3.3.2 Potential evapotranspiration and estimation by Penman's equation
 - 3.4 Infiltration
 - 3.4.1 Measurement of infiltration by Infiltrimeters
 - 3.4.2 Infiltration models: Horton; Introduction to Kostiaikov, Phillip and Green-Ampt
 - 3.4.3 Infiltration indices: Φ and W
- 4 Surface Runoff (3 hours)**
- 4.1 Factors affecting runoff from a catchment
 - 4.2 Runoff characteristics of rivers and streams
 - 4.3 Rainfall runoff relations
 - 4.4 Monthly flows by regional formulae (MIP, WECS and MHSP methods)
 - 4.5 Annual runoff hydrograph
 - 4.6 Basics of rainfall-runoff modeling
- 5 Streamflow Measurement (5 hours)**
- 5.1 Stream gauging: Site selection for stage and flow measurements
 - 5.2 Stage measurement: Staff and wire gauges; Float gauge recorder; Bubble gauge; Radar sensor
 - 5.3 Velocity measurement techniques
 - 5.4 Streamflow measurement: Velocity area method (Using current meter);
 - 5.5 Streamflow measurement through structures (Notches, weirs and flumes)
 - 5.6 Streamflow estimation by slope area method
 - 5.7 Rating curves: Development (Permanent and shifting control); Extrapolation and application
- 6 Hydrograph Analysis (8 hours)**
- 6.1 Components of a rainstorm hydrograph
 - 6.2 Factors affecting shape of rainstorm hydrographs
 - 6.3 Separation of base flow
 - 6.4 Effective rainfall hyetograph and direct runoff hydrograph
 - 6.5 Unit hydrographs: Introduction; Uses and limitations

- 6.6 Derivation of unit hydrographs from isolated and complex storms
- 6.7 Derivation of unit hydrographs of different durations (Superposition and the S-curve)
- 6.8 Synthetic unit hydrograph (Snyder's method)

7 Flood Hydrology (8 hours)

- 7.1 Design flood and its frequency
- 7.2 Relation of flood frequency with risk and lifespan of structure
- 7.3 Design floods in gauged river basins by flood frequency analysis
 - 7.3.1 Plotting positions and probability distributions for flood prediction
 - 7.3.2 Flood statistics and frequency factors
 - 7.3.3 Gumbel extreme value type I distribution
 - 7.3.4 Log Pearson type III distribution
 - 7.3.5 Log Normal distribution
 - 7.3.6 Goodness of fit tests (Chi square test)
- 7.4 Design floods in ungauged river basins
 - 7.4.1 Rational method using Mononobe's equation for rainfall intensity
 - 7.4.2 Rainfall-runoff methods: Snyder, BD Richard and PCJ models
 - 7.4.3 Regional empirical formulae: Dickens, WECS and MHSP methods
- 7.5 Flash floods
 - 7.5.1 Intense rainfall (Cloud outburst; Stationary monsoon troughs; Monsoon depressions)
 - 7.5.2 Glacial lake and landslide dammed outburst floods
 - 7.5.3 Impact of climate change on flash floods
- 7.6 Probable maximum flood (PMF)
- 7.7 Basics of flood modeling

8 Flood Routing (4 hours)

- 8.1 Concept of reservoir and channel routing; Basic equations
- 8.2 Hydrologic channel routing (Prism and wedge storage)
- 8.3 Muskingum equation and estimation of parameters (K and x)
- 8.4 Muskingum method of channel routing (Linear reservoir)
- 8.5 Clark's method for instantaneous unit hydrograph (Time area histogram)

Tutorial (30 hours)

- 1. Adequacy of rain gauges and estimation of missing rainfall
- 2. Test for inconsistencies of rainfall data (Double mass curve)
- 3. Estimation of mean rainfall over an area by 3 methods
- 4. Construction of depth duration, IDF and DAD curves
- 5. Frequency analysis of rainfall
- 6. Goodness of fit tests (Chi squared test)
- 7. Estimation of evaporation by Meyer's and Rohwer's equations
- 8. Estimation of PET by Penman's equation
- 9. Estimation of parameters of Horton's infiltration model

10. Estimation of monthly flows by rainfall-runoff equations and regional methods (MIP, WECS and MHSP)
11. Discharge computation by velocity area using current meter
12. Discharge estimation by slope area method
13. Derivation of unit hydrographs from isolated and complex storms
14. Derivation of unit hydrographs of different durations
15. Estimation of frequency of design flood based on risk and life of a structure
16. Frequency analysis of flood data and fitting of distributions (Gumbel, LPIII and LN)
17. Flood estimation by rational, regional rainfall-runoff and empirical methods
18. Estimation of Muskingum routing parameters k and x
19. Channel flood routing by Muskingum method
20. Channel routing by time area histogram and Clark's IUH

Practical

(15 hours)

1. Delineation of a catchment and estimation of monthly flows and floods by different methods of a selected river
2. Video presentation and observation of meteorological instruments
3. Video presentation and discharge measurements by current meter

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	8	8
3	6	8
4	3	4
5	5	8
6	8	12
7	8	10
8	4	6
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Subramanya, K. (2018), Engineering Hydrology (4th Edition). New Delhi, McGraw Hill Education (India) Pvt. Ltd. Chennai.
2. Reddy, P.J.R. (2011). A textbook of Hydrology (3rd Edition). University Science Press. Delhi.
3. Shaw, E. M., Beven, K., Chappell, N. A., Lamb, R. (2010). Hydrology in practice (4th ed.). CRC Press.

4. Linsley, R. K., Kohler, M. A., Paulhus, J. L. H. (1982). Hydrology for engineers (Latest Edition). McGraw-Hill.
5. Chow, V. T., Maidment, D. R., Mays, L. W. (1988). Applied hydrology (Latest Edition). McGraw-Hill.
6. Garg, S.K. (2010). Hydrology and Water Resources Engineering. Khanna Publishers. Delhi.
7. Sharma, K. P., Adhikari, N.R. (2004). Hydrological Estimations in Nepal. Department of Hydrology and Meteorology, Nepal.
8. Jha, P. C., Devkota, N. (2024), Irrigation and Drainage Engineering (3rd Edition). Heritage Publishers and Distributors, Kathmandu

ENGINEERING ECONOMICS

ENCE 307

Lecture : 3
Tutorial : 1
Practical : 0

Year : III

Part : I

Course Objectives:

The objective of this course is to provide concept of economic principles and the economic environment at the project, firm, societal, and national levels, enabling them to analyze cause-and-effect relationships. The course aims to equip students with the ability to apply economic theories and tools for project selection, equipment replacement, property valuation, and price variation. By the end of the course, students will be able to evaluate alternatives and make informed, economically sound decisions in engineering and business contexts.

1 Introduction (2 hours)

- 1.1 Micro, macro and engineering economics (History, fundamental principle and application)
- 1.2 Terminology related to engineering economics
- 1.3 Economic decision and role of engineers in decision making
- 1.4 Cash flow and cash flow diagram

2 Market Economics (3 hours)

- 2.1 Market, demand, supply and relationship
- 2.2 Elasticity, application of elasticity and government policies
- 2.3 Externality and market inefficiency
- 2.4 Market failure and firm behavior

3 Cost (8 hours)

- 3.1 Cost classification
 - 3.1.1 Total, average, fixed, variable, and marginal costs
 - 3.1.2 Direct, indirect, and standard costs
 - 3.1.3 Cash versus book cost, manufacturing and non-manufacturing cost
 - 3.1.4 Sunk cost, opportunity cost, element of cost, life-cycle cost
- 3.2 Cost estimation and control

4 Time Value of Money (6 hours)

- 4.1 Money (Type, functions and time value of money)
- 4.2 Simple and compound interests (Nominal, effective and continuous compounding)

- 4.3 Economic equivalence
- 4.4 Cash flow types (Single, uniform, linear gradient, geometric gradient and irregular)

5 Methods of Economic Analysis (12 hours)

- 5.1 Capital budgeting
- 5.2 Minimum attractive rate of return (MARR)
- 5.3 Economic analysis of single and multiple projects
 - 5.3.1 Payback period (Simple and discounted)
 - 5.3.2 Equivalent worth (Net present, annual, future and capitalized)
 - 5.3.3 Rate of return (Internal and external)
 - 5.3.4 Public Sector economic analysis (Benefit cost analysis)
 - 5.3.5 Financial and economic analysis
- 5.4 Weighted average cost of capital (WACC)
- 5.5 Repeatability assumption and co-Terminated assumptions
- 5.6 Multiple investment project alternatives (Dependent, independent and contingent)

6 Replacement Analysis (5 hours)

- 6.1 Replacement strategies (Asset life and selection of challengers over defenders)
- 6.2 Economic service life of an asset
- 6.3 Replacement strategy for asset (Project with finite and infinite planning horizon)

7 Risk Analysis (5 hours)

- 7.1 Origin of risk in projects
- 7.2 Risk analysis of projects (Sensitivity, breakeven and scenario analyses)
- 7.3 Decision tree

8 Depreciation and Taxes (5 hours)

- 8.1 Concept and terminology
- 8.2 Depreciation calculation (Straight line, declining balance, sinking fund, sum of the year digit and modified accelerated cost recovery methods)
- 8.3 Tax and corporate income tax
- 8.4 Economic analysis (After-tax cash flow)

9 Measurement of Nation Income (5 hours)

- 9.1 Gross domestic product (Components, real and nominal gross domestic product)
- 9.2 Unemployment (Measurement, job search, minimum wage law)

- 9.3 Inflation
 - 9.3.1 Causes, effects and measurement of inflation
 - 9.3.2 Constant and current cash flow
 - 9.3.3 Equivalence calculation under inflation
 - 9.3.4 Inflation controlling measures
- 9.4 Real and nominal exchange rates, fiscal budget and monetary policy
- 9.5 Financial statement

Tutorial (15 hours)

1. Cash flow diagram construction, apply and analyze it for different projects
2. Problems related to market equilibrium, elasticity, and government policies
3. Exercises on calculating interests, and analyze cash flows with economic equivalence
4. Application of capital budgeting techniques for given cash flows
5. Selection of best replacement strategies and also, apply risk analysis for real case
6. Computation of after-Tax cash flow for economic analysis
7. Calculation and analysis of gross domestic product, performing equivalence calculations under different inflation scenarios, analyze real and nominal exchange rates
8. Calculation of price variation and price escalation
9. Summarize the fiscal budget

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	3
2	3	5
3	2	3
4	6	8
5	12	16
6	5	6
7	5	6
8	5	8
9	5	5
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Mankiw, N. G. (2017). Principles of economics (8th ed.). Cengage Learning.
2. Park C.S. (2016). Contemporary Engineering Economics: Prentice Hall, Inc.
3. McConnell, C. R., Brue, S. L., Flynn, S. M. (2020). Economics: Principles, problems, and policies (22nd ed.). McGraw-Hill Education.



YEAR III, PART II

Semester 6

6 COURSES IN THIS SEMESTER

ENCE 351	Estimating and Costing	142
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ESTIMATING AND COSTING

ENCE 351

Lecture : 3
Tutorial : 1
Practical : 0

Year : III

Part : II

Course Objectives:

The objective of this course is to provide basic methods of measurement, techniques for taking out quantities, and their respective units of measurement. Students will become familiar with detailed estimates of various civil engineering structures, including buildings, roads, bridges, irrigation, sanitary and water supply systems by extracting quantities from detail drawings along with the analysis of rate of respective works based on various departmental norms. Additionally, the course covers method of approximate estimates, property valuation, and the preparation of detailed estimate and valuation reports.

1 Introduction (3 hours)

- 1.1 Definition, importance and purpose of estimation
- 1.2 Units of measurement and payment
- 1.3 Data required for estimation of civil engineering works
- 1.4 Method of measurement of earthwork, plaster work, brick work, concrete work, reinforcement and wood work

2 Methods of Quantity Estimate (4 hours)

- 2.1 Long wall short wall method
- 2.2 Center line method
- 2.3 Crossing method
- 2.4 Bay method

3 Types of Estimate (4 hours)

- 3.1 Approximate estimate, purpose and methods
- 3.2 Detailed estimate
- 3.3 Revised estimate
- 3.4 Supplementary estimate
- 3.5 Complete estimate
- 3.6 Splitting of cost of building, road, water supply and sanitary works into sub-heads
- 3.7 Detail estimation formats (Summary of cost, detail quantity estimate, analysis of rate, abstract of cost and bill of quantities)

- 4 Detail Quantity Estimate of Building Works (10 hours)**
- 4.1 Two room load bearing single-storey building with verandah
 - 4.2 Four room frame structured building with reinforcement calculations
 - 4.3 Septic tank with soak pit
 - 4.4 Underground water tank
- 5 Detail Quantity Estimate for Road, Bridge and Irrigation Works (8 hours)**
- 5.1 Pipe culverts, slab culverts and box culverts
 - 5.2 T-Beam bridge (Superstructure, abutment and pier)
 - 5.3 Well foundation
 - 5.4 Earthwork in road construction in plain and hilly areas
 - 5.5 Estimation of pavement work and retaining works in roads
 - 5.6 Earthwork and lining works in irrigation canals
- 6 Analysis of Rates (6 hours)**
- 6.1 Importance and purpose of rate analysis
 - 6.2 Data required for rate analysis
 - 6.3 Factor affecting rate analysis
 - 6.4 Prevailing rate analysis norms and district rates in Nepal
 - 6.5 Analysis of rate
 - 6.5.1 Building works: Brickwork, concrete work, reinforcement work, woodwork, plaster work and flooring work
 - 6.5.2 Road works: Earthwork in excavation/ filling using equipment; Gabion, stone masonry, plum concrete and pavement works
 - 6.5.3 Sanitary and water supply works: Wash basin; commode and pan; pipes and fittings
- 7 Valuation (4 hours)**
- 7.1 Purpose, importance and principle of valuation
 - 7.2 Concept of cost and value
 - 7.3 Factors affecting the value of the property
 - 7.4 Methods of valuation of properties
 - 7.5 Valuation report and its components
- 8 Specification (6 hours)**
- 8.1 Purpose of specifications
 - 8.2 Types of specifications
 - 8.3 Importance of specifications
 - 8.4 Methods of writing specifications
 - 8.5 Detail specifications (Site works; Structural works; Finishing works)

Tutorial**(15 hours)**

1. A two-storied residential building (Load-bearing and RCC frame structures)
2. Earthwork in the canal and lining
3. T-beam bridge with pier, abutment and well foundation
4. Calculation of earthworks for roads in plain and hilly area
5. Analysis of rates of different item of works (Building, road, sanitary, irrigation)
6. Preparation and submission of valuation report for land and buildings

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

* There may be minor deviation in marks distribution.

References

1. Chakraborti, M. (2006). Estimating, costing, specification and valuation in civil engineering (29th rev. and enlarged ed.). M. Chakraborti.
2. Dutta, B. N., Dutta, S. (1998). Estimating and costing in civil engineering: Theory and practice including specifications and valuation (24th ed.). UBS Publishers' Distributors.
3. Birdie, G. S. (2014). A text book of estimating and costing for civil engineering (New ed.). Dhanpat Rai Publishing Company Pvt. Ltd.
4. Government of Nepal. Prevailing building codes and by-laws in Nepal.

DESIGN OF RCC STRUCTURES

ENCE 352

Lecture : 4
Tutorial : 2
Practical : 2

Year : III

Part : II

Course Objectives:

The objective of this course is to equip students with the knowledge and skills needed to design various elements of building structures using reinforced concrete. The course emphasizes the limit state method of design, teaching students how to use structural analysis results to design different components according to relevant code provisions and to properly detail reinforcement. It also covers key aspects of the seismic building code, including the requirements for ductile detailing in reinforced concrete structures.

1 Reinforced Concrete Structures and Design Methods (3 hours)

- 1.1 Concept of RCC structures: Materials, advantages and limitations
- 1.2 Design methods of RCC structures
- 1.3 Characteristic strengths and loads
- 1.4 Design process and basis for design
- 1.5 Overview of relevant codes

2 Working Stress Method (4 hours)

- 2.1 Basic assumption in working stress design
- 2.2 Working load and permissible stresses in concrete and steel
- 2.3 Behavior of beam under loading
- 2.4 Types of reinforced concrete beam and different RC sections
- 2.5 Design of singly-reinforced rectangular beam

3 Limit State Method (5 hours)

- 3.1 Safety and serviceability requirements and different limit states
- 3.2 Design strength of materials and design loads
- 3.3 Idealized stress-strain diagram of concrete and steel
- 3.4 Limit state of collapse in flexure, shear, torsion and compression
- 3.5 Limit state of serviceability in deflection and in cracking
- 3.6 Concept of balanced, under-reinforced and over-reinforced sections

4 Design for Flexure (8 hours)

- 4.1 Flexural behavior of reinforced concrete
- 4.2 Design of rectangular beams
- 4.3 Design of flanged beam sections (T-beams and L-beams)

- 5 Design for Shear, Torsion and Bond (6 hours)**
- 5.1 Shear stress in beams
 - 5.2 Behavior of concrete under shear
 - 5.3 Behavior and design strength in torsion
 - 5.4 Development length
 - 5.5 Anchorage bond
 - 5.6 Flexural bond
- 6 Limit States of Serviceability: Deflection and Cracking (4 hours)**
- 6.1 Elastic theory: Cracked, uncracked and partially cracked sections
 - 6.2 Short-term and long-term deflections
 - 6.3 Control of deflection in design
 - 6.4 Control of cracking in design
- 7 Design of Slabs and Staircase (8 hours)**
- 7.1 Design of one-way and two-way slabs
 - 7.2 Detailing of one-way and two-way slabs
 - 7.3 Design and detailing of longitudinally loaded stairs
- 8 Design of Compression Members: Columns (8 hours)**
- 8.1 Effective length of columns
 - 8.2 Interaction diagrams for columns
 - 8.3 Design of short columns
 - 8.4 Design of long columns
 - 8.5 Reinforcement detailing
- 9 Design of Footings (6 hours)**
- 9.1 Design of spread footing
 - 9.2 Design of isolated footings
 - 9.3 Design of combined footings
 - 9.4 Design of mat foundation
 - 9.5 Introduction to pile caps (Basic concepts)
- 10 Reinforcement Detailing: Codal Provisions (4 hours)**
- 10.1 Requirements for good detailing
 - 10.2 Nominal cover
 - 10.3 Curtailment of flexural reinforcement
 - 10.4 Shear reinforcement
 - 10.5 Splicing of reinforcement
 - 10.6 Anchorage
 - 10.7 Bar bending schedule

11 Earthquake Resistant Design and Provisions for Ductile Detailing (4 hours)

- 11.1 Damage to RCC structures in earthquake
- 11.2 Philosophy of design of structures in earthquake prone region
- 11.3 Design for strength and ductility
- 11.4 Provision of ductility in building codes
- 11.5 Ductility requirement for beam, column and joints

Tutorial

(30 hours)

- 1. Design and detailing of rectangular and flanged beams in flexure
- 2. Design and detailing of rectangular and flanged beams in shear/torsion
- 3. Design for development length in beams
- 4. Design and detailing of rectangular and flanged beams for serviceability
- 5. Design and detailing of slabs and staircase
- 6. Design and detailing of columns
- 7. Design and detailing of footings
- 8. Ductile detailing of structural components

Practical/Assignment

(30 hours)

- 1. Testing of a beam in pure bending
- 2. Testing of a beam in pure shear
- 3. Testing of a beam in combined bending and shear
- 4. Practical work on making skeleton of beam-column connection
- 5. Practical work on making skeleton of beam-slab
- 6. Individual project on analysis and design elements of a low rise reinforced concrete building with report submission

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	3	3
2	4	3
3	5	4
4	8	10
5 and 10	10	8
6	4	4
7	8	10
8	8	8
9	6	6
11	4	4
Total	60	60

* There may be minor deviation in marks distribution.

References

1. Jain, A. K. (2002). Reinforced concrete limit state design (Reprint 2009). Roorkee, India: Nem Chand and Bros.
2. Pillai, S. U., Menon, D. (2011). Reinforced concrete design. New Delhi: Tata McGraw-Hill Education Private Limited.
3. Kong, F. K., Evans, R. H. (1987). Reinforced and pre-stressed concrete. London: ELBS.
4. Agrawal, P., Shrikhande, M. (2006). Earthquake resistant design of structures. New Delhi: PHI Learning Private Limited.
5. Dayaratnam, P. (2011). Design of reinforced concrete structures. Oxford & IBH Publishing.
6. Bureau of Indian Standards. (2000). IS 456: Plain and reinforced concrete – Code of practice.
7. Bureau of Indian Standards. (2016). IS 13920: Ductile detailing of reinforced concrete structures subjected to seismic forces – Code of practice.
8. Bureau of Indian Standards. (1987–1993). IS 875 (Parts 1–5): Code of practice for design loads (other than earthquake) for buildings and structures.
9. Government of Nepal. Prevailing building codes and by-laws in Nepal.

TRANSPORTATION ENGINEERING II

ENCE 353

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to provide students foundational knowledge in traffic engineering, traffic survey, traffic control and management, the basic principles of pavement design, the construction process of bituminous and cement concrete roads and the various problems in highway pavement and maintenance methods.

1 Traffic Studies and Analysis (13 hours)

- 1.1 Traffic volume studies
- 1.2 Traffic speed and delay studies
- 1.3 Origin and destination study
- 1.4 Basic traffic flow parameters
- 1.5 Traffic capacity and level of service
- 1.6 Parking studies
- 1.7 Crash studies

2 Traffic Control Methods (7 hours)

- 2.1 Types of intersections
- 2.2 Un-channelized and channelized intersections
- 2.3 Grade separated intersections (Overpass, underpass and interchanges)
- 2.4 Rotary intersection
- 2.5 Traffic control devices: Traffic sign, marking and islands
- 2.6 Traffic signal
- 2.7 Warrants for traffic signalization
- 2.8 Traffic signal design by Webster method
- 2.9 Traffic calming measures
- 2.10 Importance and design of street lighting

3 Pavement Design (14 hours)

- 3.1 Introduction, types and structural components of pavement
- 3.2 Factors controlling pavement design
- 3.3 Historical development of pavement structures (Flexible pavement design): Theoretical (Bousinesq and Burmister approach); Semi empirical (Tri-axial approach); and empirical methods

- 3.4 Design of flexible pavement by IRC, DoR guidelines, Road Note 31, AASHTO method
- 3.5 Rigid pavement design (Westergaard theory)
- 3.6 Design of rigid pavement by latest IRC and AASHTO method
- 3.7 Pavement design (Surface dressing method) for low cost road, IRC method

4 Road Construction Technology (7 hours)

- 4.1 Activities and techniques used in road construction
- 4.2 Road construction equipment and plants
- 4.3 Preparation of sub-grade: Excavation, fill and compaction
- 4.4 Mass Haul diagram
- 4.5 Granular, water bound macadam, soil stabilized sub base and base course
- 4.6 Prime coat and tack coat
- 4.7 Sand seal and slurry seal
- 4.8 Bituminous surface and base course: Surface dressing, grouted or penetration macadam
- 4.9 Bituminous premixes (Dense bituminous macadam; Bituminous concrete)
- 4.10 Cement concrete pavement and joints in cement concrete pavement
- 4.11 Concept on the construction of recycled pavement

5 Pavement Maintenance (4 hours)

- 5.1 Difference between maintenance and rehabilitation
- 5.2 Classification of road maintenance
- 5.3 Causes of flexible and rigid pavement failure
- 5.4 Maintenance of low cost roads (Earthen, gravel and WBM roads)
- 5.5 Maintenance of flexible pavement and rigid pavement
- 5.6 Pavement evaluation method
- 5.7 Overlay and its types
- 5.8 IRC method of overlay design for flexible pavement
- 5.9 Concept of performance based maintenance

Tutorial (30 hours)

1. Data collection, analysis, report preparation and presentation on traffic data (Volume, speed, parking, crashes and other traffic data)
2. Design of road pavement (Rigid and flexible) and usage of DOR design sheet using traffic data from tutorial 1 and CBR from cone penetration test
3. Case study on pavement failures from field inspection and presentation
4. Case study on traffic control and management

Practical (15 hours)

1. Visual presentation/demonstration on related topics of traffic engineering
2. Cone penetration test on sub grade soil for CBR
3. Skid resistance test
4. Benkelman beam deflection test

5. Traffic volume and classification count at intersection
6. Spot speed study by manual and radar gun
7. Visual inspection of road construction, road material plant, road pavement failures and report preparation

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	13	16
2	7	12
3	14	16
4	7	8
5	4	8
Total	45	60

* There may be minor deviation in marks distribution.

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IRRIGATION AND DRAINAGE ENGINEERING

ENCE 354

Lecture : 4
Tutorial : 2
Practical : 0

Year : III
Part : II

Course Objectives:

The objective of this course is to provide students the knowledge and skills for planning, design, construction, operation, maintenance and management of irrigation and drainage systems. After completion of this course students will be able to estimate irrigation and drainage requirements, design and layout of irrigation and drainage structures and river training works.

- 1 Introduction (4 hours)**
 - 1.1 Definition, need and advantages of irrigation and drainage
 - 1.2 Disadvantages of over irrigation and waterlogging
 - 1.3 Status, need and challenges of irrigation development in Nepal
 - 1.4 Crops, their seasons and periods, cropping pattern and intensity
 - 1.5 Commanded areas and irrigation intensity
 - 1.6 Methods of field irrigation and their suitability
 - 1.7 Planning of irrigation and drainage projects
- 2 Irrigation Water Requirements and Water Availability (6 hours)**
 - 2.1 Relation between duty, delta and crop periods
 - 2.2 Crop water requirements by Penman's method
 - 2.3 Operational water requirements; Losses due to seepage and evaporation
 - 2.4 Effective rainfall
 - 2.5 Irrigation efficiencies and irrigation water requirements
 - 2.6 Soil-moisture-irrigation relation
 - 2.7 Depth and frequency of irrigation
 - 2.8 Design discharges for canals
 - 2.9 Water available at source compared to irrigation requirement
- 3 Canal Irrigation System and Design of Canals (10 hours)**
 - 3.1 Classification of canals
 - 3.2 Components of a canal irrigation system
 - 3.3 Alignment of canals
 - 3.4 Canal standards and balancing canal depth
 - 3.5 Canal distribution system and methods of water distribution
 - 3.6 Sediment transport in canals and tractive force approach of canal design
 - 3.7 Design of non-alluvial stable canals
 - 3.8 Silt theories and design of alluvial canals by Lacey and Kennedy
 - 3.9 Design of lined canals with economic analysis

- 4 Diversion Headworks (14 hours)**
- 4.1 River stages and suitable location of headworks
 - 4.2 Component parts of weir/barrage (Detail drawing)
 - 4.3 Bligh's, Lane's and Khosla's seepage theories for foundation
 - 4.4 Design of weir and barrage with sloping glacis (Crest, length and thickness of impervious floor)
 - 4.5 Design of under sluice and silt excluder
 - 4.6 Design of head regulator (Crest, length and thickness of impervious floor)
 - 4.7 Design considerations of settling basin and silt ejector
- 5 River Training Works (4 hours)**
- 5.1 River characteristics and need of river training
 - 5.2 Classification and methods of river training
 - 5.3 Design of guide bund and launching apron
 - 5.4 Spurs (Types and design considerations)
 - 5.5 Flood control (Structural and non-structural methods)
- 6 Canal Regulating Structures (8 hours)**
- 6.1 Alignment of the off-taking channels
 - 6.2 Function of head and cross regulators, outlets, drops and escapes
 - 6.3 Design of regulators and escapes (Crest, length and thickness of impervious floor)
 - 6.4 Types of outlet; Design of pipe outlet (Free and submerged)
 - 6.5 Types of drop; Design of vertical drop (Crest, length and thickness of impervious floor)
- 7 Cross-Drainage Structures (6 hours)**
- 7.1 Need of cross-drainage works
 - 7.2 Types and selection of cross-drainage structures with sketch
 - 7.3 Design of siphon aqueduct (Detail drawing, drainage waterway and barrel, canal waterway and transition, RCC aqueduct, length and thickness of impervious floor, protection works)
- 8 Waterlogging and Drainage (8 hours)**
- 8.1 Causes and effects of waterlogging
 - 8.2 Symptoms of waterlogging and their detection
 - 8.3 Preventive and remedial measures of waterlogging in irrigated land
 - 8.4 Drainage of irrigated field and land reclamation
 - 8.5 Surface drainage systems and their design
 - 8.5.1 Layout planning of drainage and types of surface drains
 - 8.5.2 Internal drainage of banded fields (Drain design discharge)
 - 8.5.3 External drainage of lands from flooding

- 8.5.4 Design of surface drains (water level, maximum and minimum slopes and cross section)
- 8.5.5 Remodeling of existing natural drains
- 8.6 Subsurface drainage systems and their design
 - 8.6.1 Layout of subsurface drainage system
 - 8.6.2 Flow of ground water to drains and spacing of tile drains
 - 8.6.3 Economic diameter of tile drains

Tutorial

(30 hours)

1. Derivation of duty, delta and base period relation
2. Crop water and irrigation water requirements and water availability
3. Soil-moisture-irrigation relation, depth and frequency of irrigation
4. Balancing depth for excavating canals
5. Design of non-alluvial stable canals
6. Design of alluvial canals
7. Design of lined canals
8. Design of hydraulic structure on permeable strata by Khosla's seepage theory
9. Design of weir and barrage with sloping glacis
10. Design of under sluice and settling basin
11. Design of head regulator of main canal at headworks
12. Design of guide bund and launching apron
13. Design of cross and head regulators
14. Design of free and submerged pipe outlets
15. Design of vertical drop (Sharda Type)
16. Design of siphon aqueduct
17. Estimation of drain design discharge for bunded fields
18. Design of surface drains
19. Design of sub-surface tile drains

Assignment and Field Observation

1. Individual assignment with report on "Irrigation water requirement for a commanded area (Manual and using software) and water availability at headworks of a selected river"
2. Visual presentation/demonstration of structural components and hydraulic processes of irrigation and drainage system
3. Field based observation of an irrigation system and submission of individual report with sketches and functions of observed irrigation structures

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

* There may be minor deviation in marks distribution.

References

1. Garg, S. K. (2023). Irrigation engineering and hydraulic structures. Khanna Publishers.
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6. Garg, S. K. (2010). Hydrology and water resources engineering. Khanna Publishers.
7. Jha, P. C., Devkota, N. (2024). Irrigation and drainage engineering. Heritage Publishers & Distributors.

PROFESSIONAL AND SOCIAL ENGINEERING

ENCE 355

Lecture : 3
Tutorial : 1
Practical : 0

Year : III
Part : II

Course Objectives:

The objective of this course is to introduce the interrelationship among technology, environment, and society, emphasizing the ethical, professional, and legal responsibilities of engineers. It aims to develop the ability to apply professional ethics, comply with institutional and legal provisions, communicate effectively, and engage responsibly with stakeholders and communities while recognizing the broader societal role of engineering practice.

1 Technology, Environment and Society (10 hours)

- 1.1 Early civilization and engineering practices
- 1.2 Cultural and social influence of technology
- 1.3 Environment and society; Role and impact of technology
- 1.4 Environmental conservation
 - 1.4.1 Ecosystem and conservation of environment
 - 1.4.2 Conservation of natural resources and wildlife in infrastructure development (Impact on natural resources; Significance; Ecology and behavior; Conservation)
 - 1.4.3 Global and regional environmental issues
- 1.5 Resource efficiency and sustainable technologies
 - 1.5.1 Renewable and non-renewable resources
 - 1.5.2 Waste management and recycling technologies
 - 1.5.3 Green engineering and design practices
- 1.6 Natural resources safeguards: Principle and practices

2 Ethics and Professionalism (8 hours)

- 2.1 Ethics, morality, and professionalism
- 2.2 Ethical responsibilities toward sustainability and safety
- 2.3 Code of conduct and professional behavior
- 2.4 Responsibility, liability, and negligence
- 2.5 Conflict of interest, corruption, and whistleblowing
- 2.6 Ethical decision-making and case studies

3 Engineering Practice and Legal Framework (10 hours)

- 3.1 Engineering Council and professional associations
- 3.2 Professional regulations

- 3.3 Engineering enterprises
- 3.4 Licensing and disciplinary procedures
- 3.5 Contract types and Public Procurement Act
- 3.6 Labor law and occupational safety
- 3.7 Intellectual property and arbitration
- 3.8 Conflict resolution techniques

4 Professional Skill and Career Development (5 hours)

- 4.1 Proposal writing and reporting
- 4.2 Professional correspondence
- 4.3 Communication, teamwork, and leadership
- 4.4 Continuing Professional Development (CPD)

5 Social Engineering (6 hours)

- 5.1 Concept and scope of social engineering
- 5.2 Elements of society and community and their difference
- 5.3 Social inclusion and decision making
- 5.4 Stakeholders: Identification, mapping, analysis, engagement and communication
- 5.5 Corporate social responsibility (CSR)

6 Engineers in Society (6 hours)

- 6.1 Engineer as an agent of change
- 6.2 Public accountability and ethical citizenship
- 6.3 Balancing technical and social expectations
- 6.4 Contribution to Sustainable Development Goals (SDGs)

Tutorial (15 hours)

- 1. Debate to apply ethical principles in practical engineering situations.
- 2. Group discussion to analyze interactions among technology, environment, and society.
- 3. Case critique to evaluate professional conduct and legal obligations.
- 4. Class room workshop to demonstrate proposal writing and professional communication skills.
- 5. Stakeholder mapping exercise to identify and analyze interests and influence in infrastructure projects.
- 6. Discussion to explore social inclusion and corporate social responsibility (CSR) practices.
- 7. Reflective session to assess teamwork, leadership, and continuing professional development (CPD).
- 8. Case presentation to synthesize ethical, legal, and social dimensions of engineering practice.

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	10	12
2	8	10
3	10	14
4	5	6
5	6	8
6	6	10
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Whitbeck, C. (2012), Ethics in Engineering Practice and Research, Cambridge University Press.
2. Martin, M. W., Schinzinger, R. (2004). Ethics in engineering. New York, NY: McGraw-Hill.
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STRUCTURAL DYNAMICS

ENCE 365

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to equip students with an understanding of the basic concepts of structural dynamics and the dynamic behavior of structures, along with the underlying principles required to analyze and solve dynamic problems of structures.

1 Introduction (6 hours)

- 1.1 Structural dynamics (Dynamic loading, structural behavior and response)
- 1.2 Essential characteristics of a dynamic problem
- 1.3 Equation of motion (Newton's second law of motion and D'Alembert's principle) and dynamic degrees of freedom
- 1.4 Types of vibrations (Free, forced, damped and undamped)
- 1.5 Types of dynamic loading (Simple harmonic, periodic, transient, impulsive, and random)
- 1.6 Damping: Definition, characteristics, and types (Viscous, coulomb, structural, aerodynamic, magnetic, viscoelastic, and active)
- 1.7 Dynamic response of structures
- 1.8 Time-domain and frequency-domain analysis

2 Single-degree-of-freedom System (20 hours)

- 2.1 Equations of motion: Modeling of single-degree-of-freedom system, response parameters, effect of gravity, effect of support excitation, combination of stiffness (Parallel and series)
- 2.2 Free vibration response: Undamped system; Damped system (Under critically, critically, and over critically)
- 2.3 Logarithmic decrement of response
- 2.4 Forced vibration response to harmonic loading: Undamped system; Damped systems (Transient response, steady-state response, general response, and resonance response)
- 2.5 Energy dissipated by damping (Viscous damping)
- 2.6 Forced vibration response to periodic loading: Undamped system (Transformation of loading and response using Fourier series)
- 2.7 Forced vibration response to impulsive load (Half-sine wave pulse, rectangular pulse, ramp pulse, triangular pulse)

- 2.8 Forced vibration response to general dynamic loading: Unit-impulse and Dirac-delta function; Unit-impulse response function; Duhamel integral and Convolution integral; Numerical evaluation of Duhamel integral
- 2.9 Vibration measuring instruments (Displacement meter and accelerometer)
- 2.10 Vibration isolation (Vertical oscillating force, harmonic motion of the base, force transmissibility, unbalanced mass amplitude of rotating unbalanced system)
- 2.11 Computer simulation of dynamic responses of single-degree-of-freedom system: Free; Forced; Undamped damped (Under critical, critical, and over critical); Resonance effect

3 Multi-degrees-of-freedom System (8 hours)

- 3.1 Simple system (Basic concept, uses and limitations)
- 3.2 Generalized coordinate and reduction of degrees of freedom (Kinematic constraints and static condensation)
- 3.3 Dynamic equilibrium: Mathematical modeling and dynamic equilibrium equation; influence coefficients (Stiffness influence coefficients, damping influence coefficients, and mass influence coefficients)
- 3.4 Free vibration analysis of undamped system: Eigen value problem (natural frequencies and mode shapes)
- 3.5 Free vibration response of undamped system: Modal expansion; Orthogonality conditions; Normalization; Normal coordinates; Uncoupled equations of motion; Mode superposition method
- 3.6 Modal response analysis of damped systems
- 3.7 Forced vibration response of damped and undamped system
- 3.8 Dynamic analysis of linear multi-degrees-of-freedom system: Response spectrum analysis; Element forces; Modal contribution factors and minimum number of modes; Base shear; Modal mass
- 3.9 Evaluation of natural frequencies and mode shapes (Iterative methods): Rayleigh's method; Stodola's method; Holzer's method
- 3.10 Support excitation (Influence vector, synchronous support motion of a planar system, and structure with multiple support motions)

4 Continuous Systems (4 hours)

- 4.1 Partial differential equations of motion (Transverse vibration of a string and beam; axial vibration of a bar)
- 4.2 Evaluation of natural frequencies and mode shapes (Transverse vibration of a string and beam)

5 Application of Finite Element Method in Structural Dynamics (7 hours)

- 5.1 Basic concept of finite element method: Node and element; types and characteristics of finite element, local and global coordinate system; Discretization and meshing; shape functions; Nodal forces, Nodal

- displacements, Elemental stiffness matrix and structural (Global) stiffness matrix
- 5.2 Formulation of shape function and stiffness matrix (Bar and beam elements)
- 5.3 Convergence and compatibility

Tutorial

(30 hours)

1. Evaluation of equivalent stiffness and fundamental frequency for structural systems with lateral-load-resisting elements in parallel and series combinations
2. Evaluation and plotting of vibration responses for an single-degree-of-freedom system (Undamped free vibration, undamped forced vibration, damped free vibration damped forced vibration, periodic and impulse loading)
3. Determination of the vibration response due to general dynamic loading using Duhamel's integral by applying both the analytical approach and numerical integration methods
4. Evaluation of the modal frequencies and mode shapes using the Eigen value method including sketches of the mode shapes
5. Determination of displacements and velocities of the free and forced vibration with damped and undamped system for the given initial conditions
6. Determination of displacements and velocities of the undamped and damped free vibration system for given initial conditions
7. Determination of several parameters of damped free vibration system of realistic problems (Such as elevated water tank, portal frame, and others): Damping ratio, natural period, equivalent stiffness, weight, damped natural frequency, damping coefficient, number of cycles required for the targeted reduced displacement amplitude, logarithmic decrement, and others
8. Determination of force transmissibility ratio and force due to rotation unbalance of machine
9. Determination of responses due to several types of periodic and impulsive loading (Half-sine wave, triangular, step or rectangular, ramp, and blast)
10. Evaluation of responses due to general dynamic loading: (General integration and numerical evaluation approach)
11. Determination of modal frequencies and mode shape vector and plotting the mode shapes of Eigen value problem of MDOF system
12. Evaluation and plotting of vibration responses for multi-degrees-of-freedom system using modal superposition method
13. Determination of modal frequencies of multi-degrees-of-freedom system using iterative methods (Rayleigh's method, Stodola's method, and Holzer's method)
14. Evaluation of the natural frequencies and plotting the mode shapes of vibrations (Transverse or axial) for continuous structural systems (String, bar and beam)

15. Evaluation of the nodal displacements of 1D bar problem and simple truss under point load and UDL

Practical

(15 hours)

1. Free vibration of a simple cantilever beam
2. Mass-spring system: Determination of natural frequency
3. Damping in a simple pendulum
4. Dynamic response of a multi-story frame model
5. Modal analysis of MDOF system using FEM-based software

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	20	30
3	8	10
4	4	6
5	7	8
Total	45	60

* There may be minor deviation in marks distribution.

References

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2. Paultre, P. (2013). Dynamics of structures. John Wiley & Sons.
3. Jain, A.K. (2016). Dynamics of structures with MATLAB applications. Pearson.
4. Chopra, A.K. (2017). Dynamics of structures: Theory and applications to earthquake engineering. Pearson.
5. Paz, M., Leigh, W. (2010). Dynamics of structures: Theory and computation. Springer.
6. Thompson, W.T., Dahleh, M. D. (1998). Theory of vibration with applications (Latest Edition). Prentice Hall.
7. Cook, R.D. (1981). Finite element analysis (Latest Edition). John Wiley & Sons.
8. Belegundu, A. D., Chandrupatla, T. R. (2011). Introduction to finite elements in engineering. Pearson.

TRAIL SUSPENSION BRIDGES

ENCE 366

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to provide students the theoretical and practical background required for planning, survey, design, execution and maintenance of trail bridges.

- 1 Introduction (4 hours)**
 - 1.1 Historical background
 - 1.2 Development of trail bridges
 - 1.3 Classification of trail bridges
 - 1.4 Types of trail bridges
 - 1.5 Components of trail Bridges
 - 1.6 Specification of materials: Wire rope; Reinforcement; Structural steel; Wire mesh netting; Bulldog grip; Thimble; Nuts and bolts
 - 1.7 Planning procedures: Socio-economical assessments; Preliminary site investigations
- 2 Trail Bridge Survey (4 hours)**
 - 2.1 Desk study
 - 2.2 Preparation for survey
 - 2.3 Site reconnaissance
 - 2.4 Site selection
 - 2.5 Preliminary design
 - 2.6 Bridge axis survey
 - 2.7 Bridge site survey
 - 2.8 Geotechnical and geological assessment: Design parameters
 - 2.9 Site photographs
- 3 Analysis and Design of Cable Structure (8 hours)**
 - 3.1 Loads on trail bridges
 - 3.2 Cable properties
 - 3.3 Cable geometry
 - 3.4 Sag calculation for D-type and N-type bridges
 - 3.5 Design of main and hand rail cables for D-type bridges
 - 3.6 Design of main cables for N-type bridges
 - 3.7 Design of spanning cables

- 4 Design of Short Span Trail Bridges (SSTB) (5 hours)**
- 4.1 SSTB: D-type and N-type steel and construction drawing manuals
 - 4.2 Determination of bridge span of SSTB D-type and N-type bridges
 - 4.3 Selection of cable combination for D-type and N-type bridges
 - 4.4 Selection of foundation block for D-type and N-type bridges
 - 4.5 Selection of tower for N-type bridge
- 5 Long Span Trail Bridges (LSTB) (14 hours)**
- 5.1 LSTB: D-type and N-type steel and construction drawing manuals
 - 5.2 Design of the trail bridge cable: Cable design for suspended bridges; Cable design for suspension bridges
 - 5.3 Wind effect and bridge stability
 - 5.4 Wind loads on bridges
 - 5.5 Design of wind-guy and Wind-ties cables
 - 5.6 Design of tower for suspension bridges
 - 5.7 Design of suspenders for suspension bridges
 - 5.8 Design of bridge foundations
 - 5.9 Drawings, cost estimating and reports
- 6 Construction of Trail Bridges (7 Hours)**
- 6.1 Transportation and handling of bridge parts
 - 6.2 Storage of bridge parts
 - 6.3 Fabrication: Specification of materials, quality check and fabrication plant requirement
 - 6.4 Galvanization: Introduction, galvanization process, quality check and specification for different bridge parts
 - 6.5 Layout: SSTB D/N-type bridges, LSTB D/N-type bridges with/without wind guy cable
 - 6.6 Earth works and civil works
 - 6.7 Bridge erection: Tower erection; Cable hoisting (D-type and N-type bridges)
 - 6.8 Fitting of bridge parts
 - 6.9 Quality control and finishing works
- 7 Maintenance of Trail Bridges (3 hours)**
- 7.1 Importance of maintenance
 - 7.2 Routine maintenance
 - 7.3 Major maintenance
 - 7.4 Survey and design of maintenance works
 - 7.5 Rehabilitation of bridges

Tutorial**(30 hours)**

1. Calculation of hoisting and full load sag
2. Design of cable for D and N type bridges
3. Design of suspenders
4. Design of all types of foundation for D and N types bridges

Practical/Assignment**(15 hours)**

1. SSTB D-type bridge
2. SSTB N-type bridge
3. LSTB D-type bridge
4. LSTB N-type bridge
5. Visual presentation/demonstration/observation of trail suspension bridges

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	4	6
2	4	6
3	8	12
4	5	6
5	14	16
6	7	10
7	3	4
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Suspension Bridge Division, Department of Roads, Institute of Engineering. (2003). A course manual on trail bridges.
2. Department of Local Infrastructure Development and Agricultural Roads, Trail Bridge Section. (2003). Short span trail bridge standard: Technical handbook: How to build a short span trail suspended bridge (Vol. I and II).
3. Department of Local Infrastructure Development and Agricultural Roads, Trail Bridge Section. (2003). Short span trail bridge standard: Steel and construction drawings.
4. Department of Local Infrastructure Development and Agricultural Roads, Trail Bridge Section. (2004). Long span trail bridge standard: Technical manual.
5. Swiss Centre for Development and Cooperation. (2003). Short span trail suspended bridge: Technical handbook.
6. Swiss Centre for Development and Cooperation. (1992). Long-span trail bridge standard: Technical manual.

SEISMIC RESISTANT DESIGN OF MASONRY STRUCTURES

ENCE 367

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to provide students the theoretical and practical knowledge on earthquake and its effect on masonry structures, mainly failure mechanism and design of earthquake resistant masonry structures using codes. Students will be able to understand how masonry structures respond to earthquakes, effects on structure due to earthquake forces such as bending, and shear. Students will also learn to apply building codes to design safe and durable masonry buildings capable of withstanding earthquakes.

1 Earthquakes and Seismic Ground Motion (6 hours)

- 1.1 Origin of earthquake
- 1.2 Seismic waves, earthquake ground motion, magnitude and intensity
- 1.3 Occurrence of earthquakes; loss and damages
- 1.4 Time history, frequency spectra, and response spectra of earthquake force
- 1.5 Effects of earthquake on building

2 Masonry Structures (8 hours)

- 2.1 History of masonry structures in ancient and modern times
- 2.2 Nature of masonry structures
- 2.3 Mechanical and physical properties of masonry; Masonry materials (Units, mortar, and walls)
- 2.4 Types of masonry structures (Load bearing masonry, confined masonry, and infill masonry); Types of walls
- 2.5 Lateral force resisting elements (Walls, piers, and arches)
- 2.6 Structural system of historical masonry structures; Review on design of masonry walls for static force
- 2.7 Emerging materials and technologies in masonry structures

3 Seismic Behavior of Masonry Structures (10 hours)

- 3.1 Basic concept of seismic effect in masonry structure; Failure mechanism
- 3.2 Historical buildings with seismic resisting features
- 3.3 Lateral force resisting systems
- 3.4 In-plane and out-of-plane behavior of walls
- 3.5 Box-integrity-action of masonry structures

- 3.6 Modes of failure of masonry structures
- 3.7 Typical damages to masonry buildings in earthquakes
- 3.8 Seismic performance due to various factors (Geometrical and mass irregularities; Opening size and location; Eccentrically acted gravity load; eccentrically lateral force; Rigid and flexible floor diaphragm; Slender wall; horizontal and vertical bands; Material properties; Construction quality)
- 3.9 Seismic performance of masonry building during past earthquakes

4 Seismic Analysis and Design of Masonry Buildings (12 hours)

- 4.1 Principle of seismic design of masonry structures
- 4.2 Historical perspective on seismic design of masonry structures
- 4.3 Code provisions and calculation of seismic forces
- 4.4 Determination and distribution of lateral forces based on flexibility of diaphragms (IS 1893: 2016 or NBC 105: 2020)
- 4.5 Rigidity of shear wall considering opening effects
- 4.6 Direct and torsional shear force in shear walls
- 4.7 Increase in axial load in piers due to overturning
- 4.8 Wall subjected to out of plane bending
- 4.9 Stability check of flexural wall for out-of-plane forces
- 4.10 Additional forces due to arching action (Rigid and gapped arching)

5 Reinforced Masonry (5 hours)

- 5.1 Basic concept
- 5.2 Vertical and horizontal one-way flexural behavior
- 5.3 Two-way flexural behavior
- 5.4 Flexural and shear strength
- 5.5 Reinforced masonry column, beam, and bands

6 Repair and Strengthening Methods for Existing Masonry Buildings (4 hours)

- 6.1 Basic concept of repair, rehabilitation and retrofitting
- 6.2 Vulnerability assessment and methods
- 6.3 Retrofitting materials
- 6.4 Retrofitting techniques and various methods/approaches for masonry structures based on failure mechanism
- 6.5 Existing retrofitting practice of masonry structures in Nepal
- 6.6 Existing retrofitting practice in Nepal

Tutorial (30 hours)

- 1. Design of walls for gravity load
- 2. Calculation of center of mass, center of rigidity and eccentricity of lateral force
- 3. Calculation and distribution of lateral loads using IS 1893 and NBC 105
- 4. Distribution of seismic force on shear wall connected with rigid and flexible floor

5. Determination of rigidity of shear wall considering opening
6. Determination of direct shear force and torsional shear force
7. Determination of increase in axial load due to overturning
8. Determination of nominal allowable load carrying capacity of the wall subjected to out of plane bending
9. Stability check of flexural wall for out-of-plane forces
10. Determination of additional force due to arching action
11. Design of reinforced masonry walls (Flexure and shear capacity)
12. Design of reinforced concrete bands along with corner stitches

Practical

(15 hours)

1. Survey and selection of a two storey masonry building
2. Preparation of asbuilt drawing
3. Calculation of loads: Dead, live and earthquake, calculate and analyze effects on building elements
4. Analysis and seismic resistant design and preparation of design report

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	8
2	8	8
3	10	14
4	12	18
5	5	6
6	4	6
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Tomazevic, M. (1999). Earthquake-resistant design of masonry buildings (Latest Edition). Imperial College Press.
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4. Hendry, A. W., Sinha, B. P., Davies, S. R. (2017). Design of masonry structures. CRC Press.
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7. Arya, A., Boen, T., Ishiyama, Y., Martemianov, A., Meli, R., Scawthorn, C., Vargas, J., Yaoxian, Y. (2010). Guidelines for earthquake resistant non-engineered construction.

WATERSHED ENGINEERING AND MANAGEMENT

ENCE 368

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to make students competent to apply agronomic, vegetative and engineering measures for soil and water conservation in a watershed with required management plan. After completion of the course the students will be able to design soil and water conservation structures like contour bunds, graded bunds, grassed waterways, terraces, gully control structures, water retaining and storage structures, sediment retention and flood control structures after estimating runoff and soil loss from a watershed.

- 1 Introduction (2 hours)**
 - 1.1 Soil erosion and landslide problems; Need of soil and water conservation
 - 1.2 Concept and approaches of watershed engineering and management
 - 1.3 Watershed operations: Physiography; Rainfall-runoff and soil loss analyses; Measures and operations
 - 1.4 Condition of watersheds in Nepal and their future development
- 2 Runoff and Soil Loss (5 hours)**
 - 2.1 Soil and water: Soil characteristics (Composition, profile, texture and structure); Infiltration and soil moisture conditions; Surface runoff and ground water; Mechanics of soil erosion
 - 2.2 Types of soil erosion and landslides: Surface erosion (Splash, sheet and rill); Gully erosion; Stream bank erosion; Landslides and movement
 - 2.3 Estimation of peak runoff (Design flood): Rational method; Regional methods (WECS, DHM, MHSP, Dickens, PCJ)
 - 2.4 Estimation of soil loss: Soil loss factors; Universal soil loss equation (USLE)
- 3 Land Capability Classification for Watershed Management (2 hours)**
 - 3.1 Land capability classification of Nepal
 - 3.2 Characteristics of land capability classes (LCC)
 - 3.3 Land use and soil conservation practices of LCC
- 4 Agronomic Measures for Soil and Water Conservation (4 hours)**
 - 4.1 Contour farming and cultivation
 - 4.2 Strip cropping

- 4.3 Conservation farming: Tillage conservation; Crop rotation; Multiple cropping; Cover crop; Farm yard manure; Micro irrigation methods
- 4.4 Grassland farming
- 4.5 Agro-forestry
- 4.6 Horticulture

5 Bioengineering Measures for Soil and Water Conservation (4 hours)

- 5.1 Vegetative conservation techniques: Fascines; Palisades; Grass planting; Watling; Bamboo Planting; Live Fencing; Brush Layering
- 5.2 Natural hazard prevention: Gully treatment; Landslide treatment; Stream bank protection; Degraded land rehabilitation
- 5.3 Protection of developed infrastructures: Irrigation channel stabilization; Trail improvements; Road slope stabilization; Water source protection

6 Engineering Measures for Conservation of Agricultural Land (8 hours)

- 6.1 Bunding
 - 6.1.1 Contour bunding (Design criteria, specification and design)
 - 6.1.2 Graded bunding (Design criteria, specification and design)
 - 6.1.3 Construction and maintenance of contour and graded bunds
- 6.2 Terracing
 - 6.2.1 Bench terraces (Design, construction and maintenance)
 - 6.2.2 Broad base terraces (Design, construction and maintenance)
- 6.3 Drainage structures and grassed waterways
 - 6.3.1 Drainage structures (Types, design of surplus weir and pipe outlet)
 - 6.3.2 Grassed waterways (Types, design, construction and maintenance)

7 Engineering Measures for Conservation of Non-Agricultural Land (8 hours)

- 7.1 Contour and staggered trenching
- 7.2 Gully control structures (Types and application)
 - 7.2.1 Temporary and semi-permanent check dams
 - 7.2.2 Permanent spillway structures: Types; Design of straight drop, drop inlet and chute spillways
- 7.3 Design of sediment retention structure
- 7.4 Design of soil retaining wall

8 Water Harvesting and Conservation (6 hours)

- 8.1 Water conservation for cropland
- 8.2 Broad bed and furrow system; Conservation bench terraces; Tied ridging or furrow damming; Contour furrows; Catch Pits
- 8.3 Small storage structures: Conservation ponds; Small weirs; Small earthen and masonry dams; Sand dams
- 8.4 Design of conservation pond and small earthen dam
- 8.5 Recharge and use of ground water

9 Watershed Management

(6 hours)

- 9.1 Causes and consequences of watershed deterioration
- 9.2 Objectives and steps of watershed management
- 9.3 People's participation in watershed management
- 9.4 Watershed management plan (WMP)
- 9.5 Formulation of project proposal

Tutorial

(30 hours)

1. Estimation of design flood by Rational and Regional (WECS, DHM, MHSP, Dickens and PCJ) methods
2. Estimation of soil loss by universal soil loss equation (USLE)
3. Design of contour and graded bunds
4. Design of bench and broad base terraces
5. Design of surplus weir and pipe outlet
6. Design of trapezoidal and parabolic grassed waterways
7. Design of straight drop, drop inlet and chute spillways
8. Design of sediment retention structure
9. Design of soil retaining wall
10. Design of conservation pond and small earthen dam

Practical/Assignment

(15 hours)

1. Visual presentation/demonstration/observation on soil erosion/landslide processes and watershed structures
2. Individual assignment on delineation of a catchment and estimation of design floods by different methods of a selected river with report submission

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

* There may be minor deviation in marks distribution.

References

1. Tiedeman, E. M. (1996). Watershed management: Guidelines for Indian conditions (Latest Edition). Omega Scientific Publishers.
2. Suresh, R. (1997). Soil and water conservation engineering (Latest Edition). Standard Publishers Distributors.
3. Schwab, G. O., Fangmeier, D. D., Elliot, W. J., Frevert, R. K. (2018). Soil and water conservation engineering. John Wiley & Sons, Inc.
4. NARMSAP NEPAL and Department of Soil Conservation and Watershed Management (2004). Soil Conservation and Watershed Management Measures and Low Cost Techniques. Kathmandu.
5. Department of Soil Conservation and Watershed Management. (1987). Watershed Planning Manual no. 4, Land Capability Classification.
6. Singh, G., Sastry, G., Joshi, B. P. (2023). Manual of soil and water conservation practices. CBS Publishers & Distributors.
7. Jha, P. C., Devkota, N. (2024). A textbook of irrigation and drainage engineering. Heritage Publishers & Distributors.
8. Suresh, R. (2017). Watershed planning management. Standard Publishers.

RIVER AND SEDIMENT ENGINEERING

ENCE 369

Lecture : 3
Tutorial : 2
Practical: 1

Year: III
Part: II

Course Objectives:

The objective of this course is to develop fundamental skills for collecting sediment related data in the field, essential for sedimentation studies and river engineering projects. Upon successful completion, students will also be able to design basic sediment management, as well as river training and protection works.

1 Introduction (3 hours)

- 1.1 History of sediment transport and river engineering
- 1.2 Rivers and the water-rock cycle link
- 1.3 Key water infrastructures projects in rivers
- 1.4 Sediment induced problems in water infrastructure projects
- 1.5 Spatial and temporal scales in sedimentation and river engineering

2 Properties of Sediment (2 hours)

- 2.1 Characteristics of sediment grains: Size, shape and classifications
- 2.2 Sampling of bed deposits
- 2.3 Density, porosity and their measurements
- 2.4 Particle fall velocity, measurement and estimation
- 2.5 Angle of repose

3 Sediment Erosion and Yield (4 hours)

- 3.1 Weathering, erosion and sediment yield
- 3.2 Inter-rill and rill erosion
- 3.3 Gully erosion
- 3.4 Channel erosion
- 3.5 Mass wasting
- 3.6 Sediment delivery ratio (SDR)
- 3.7 Erosion modelling using universal soil loss equation (USLE)
- 3.8 Erosion modelling using erosion potential model (EPM)

4 Sediment Transport (6 hours)

- 4.1 Roughness in river bed: form and skin drag
- 4.2 Initiation of motion and transport modes
 - 4.2.1 Critical velocity

- 4.2.2 Critical bed-shear stress
- 4.2.3 Initiation of suspension
- 4.2.4 Sediment transport modes
- 4.3 Bed-load transport
 - 4.3.1 Deterministic methods
 - 4.3.2 Stochastic methods
 - 4.3.3 Bed-load transport of non-uniform material
- 4.4 Suspended load transport
 - 4.4.1 Concentration profiles
 - 4.4.2 Reference concentration and levels
 - 4.4.3 Suspended load transport rates

5 Monitoring of Suspended Sediments (4 hours)

- 5.1 Iso-kinetic sampling
 - 5.1.1 Sampling methods
 - 5.1.2 Samplers
- 5.2 Sampling location and handling of samples
- 5.3 Laboratory analysis
 - 5.3.1 Concentration analysis
 - 5.3.2 Particle size distribution
 - 5.3.3 Mineral content analysis
 - 5.3.4 Organic content analysis
- 5.4 Surrogate methods of suspended sediment measurements
- 5.5 Data analysis

6 Sediment Handling in Run-of-River and Storage Projects (12 hours)

- 6.1 Sediment handling in run-of-river projects
 - 6.1.1 Sediment handling strategies
 - 6.1.2 Bed-load handling
 - 6.1.3 Suspended sediment handling
- 6.2 Operation of peaking reservoir
- 6.3 Sediment transport and deposition in reservoir
- 6.4 Trap efficiency and life of reservoir
- 6.5 Design paradigm of storage projects
- 6.6 Sediment handling in storage projects
 - 6.6.1 Reducing sediment yield
 - 6.6.2 Sediment routing
 - 6.6.3 Redistributing or removing sediment deposits
 - 6.6.4 Adaptive strategies

7 Fundamentals of River Engineering (6 hours)

- 7.1 River planform
- 7.2 Flow in river bends
- 7.3 Bank-full and formative discharge concept

- 7.4 Sediment continuity and river bed changes
- 7.5 Stable channels and regime theories
- 7.6 Propagation of bed perturbations
- 7.7 Short-term development of shoals and trenches
- 7.8 Analytical model for reach scale equilibrium
 - 7.8.1 Response to permanent flow abstraction
 - 7.8.2 Response to sediment mining

8 Bank Erosion and River Training Works (4 hours)

- 8.1 Mechanics of bank erosion
- 8.2 Design of groynes
- 8.3 Design of embankments
- 8.4 Indigenous river training and protection methods

9 Bridge Foundation Scour and Protection (4 hours)

- 9.1 Bridge foundation scour
- 9.2 Approach flow and morphological consideration
- 9.3 Estimation and modelling of bridge foundation scour
- 9.4 Scour protection measures

Tutorial (30 hours)

- 1. Computation of particle size distribution and size related parameters of sediment mixture
- 2. Determination of fall velocity of natural sediment using different formulas
- 3. Estimation of sediment yield using USLE and EPM methods
- 4. Estimation of bed-load transport using various equations
- 5. Estimation of suspended load transport using various equations
- 6. Computation of sediment load using various methods
- 7. Derivation of discharge versus suspended sediment concentration rating curve from the observed sediment concentration and discharge data
- 8. Estimation of dimension of channels based on different regime theories
- 9. Derivation of equations for the propagation of small bed perturbations
- 10. Derivation of developments of shoals and trenches
- 11. Determination of short-term and long-term river response to discharge and sediment abstraction
- 12. Design of groynes and embankments
- 13. Estimation of bridge scour

Practical/Assignment (15 hours)

- 1. Visual presentation/demonstration of river-sediment transport processes
- 2. Determination of sediment concentration in a water-sediment mixture using the filtration method in laboratory
- 3. Individual assignment on erosion modelling by USLE and EPM

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

* There may be minor deviation in marks distribution.

References

1. Dey, S. (2014). Fluvial Hydraulics: Hydrodynamic and Sediment Transport Phenomena. Springer-Verlag.
2. Garcia, M. (Ed.). (2008). Sedimentation Engineering. American Society of Civil Engineers.
3. Julien, P. (2002). River Mechanics. Cambridge University Press.
4. Moris, G., Fan, J. (1998). Reservoir Sedimentation Handbook. McGraw-Hill.
5. Van Rijn, L. (1993). Principles of Sediment Transport in River, Estuaries and Coastal Areas (Latest Edition). Aqua Publication.

COMPUTATIONAL TECHNIQUES IN WATER RESOURCES ENGINEERING

ENCE 370

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to equip students with computational techniques for solving complex problems in water resources engineering. The course emphasizes the application of numerical methods to simulate and analyze open channel flow, groundwater seepage, and unsteady flow in pipe systems, alongside the use of optimization approaches for water resources management. By the end of the course, students will be able to apply computational tools to effectively model, evaluate, and optimize water resources systems for practical engineering decision-making.

- 1 Computational Techniques (6 hours)**
 - 1.1 Role of computational techniques in water resources
 - 1.2 Types of models: Deterministic, stochastic, data-driven
 - 1.3 Methods of computation: Finite difference method (FDM); Finite element method (FEM); Finite volume method (FVM)
 - 1.4 Initial and boundary conditions
 - 1.5 Software overview related to water resources
 - 1.6 Saint Venant equations: Assumptions, equations in conservative and non-conservative forms

- 2 Finite Difference Method (9 hours)**
 - 2.1 Mathematical theory of FDM: Forward difference approximation; Backward difference approximation; Central difference approximation; Steps in FDM
 - 2.2 Order of accuracy; Truncation error
 - 2.3 Concept of consistency, convergence and stability
 - 2.4 Explicit and implicit schemes
 - 2.5 Kinematic and dynamic wave celerity
 - 2.6 Finite difference solution of kinematic wave model (Explicit only)
 - 2.7 Finite difference solution of dynamic wave model (Explicit and implicit)

- 3 Method of Characteristics (MOC) (12 Hours)**
 - 3.1 Characteristics; Solution requirements; Advantages; Limitations
 - 3.2 Characteristics equations to open channel and pipe flow
 - 3.3 Finite difference solution of characteristics equations of unsteady pipe flow
 - 3.4 Algorithm for solving water hammer problem using rectangular grid

- 3.5 Stability of MOC solution
- 3.6 Boundary conditions for unsteady pipe flow problem
- 3.7 MOC for 1D gradually varied unsteady open channel flow
- 3.8 Numerical (FDM) solution of MOC for 1D unsteady open channel flow

4 Simulation of Groundwater Flow (9 Hours)

- 4.1 Basic equation of groundwater flow and flow-net analysis: Darcy's Law; Steady continuity equation for incompressible flow; Equipotential line; Stream line; Flow potential; Flow-net; Rules for constructing flow-net in isotropic medium
- 4.2 Finite difference scheme for 2D groundwater simulation
- 4.3 Simulation of seepage under a dam based on steady state 2D model
- 4.4 1D implicit model for simulating river stage and groundwater table interaction

5 Optimization Techniques in Water Resources (9 Hours)

- 5.1 Introduction: Role and importance of optimization in water resources planning and management; Types of optimization problems (single-objective, multi-objective, deterministic and stochastic)
- 5.2 Linear programming (LP): Formulation of LP problems (objective function, constraints, and decision variables); Application in reservoir operation and canal scheduling
- 5.3 Nonlinear programming (NLP): Overview of NLP problems and solution approaches; Applications in groundwater remediation, water allocation, and hydropower scheduling
- 5.4 Dynamic programming (DP): Principle of optimality; Recursive solution approach; Application to multi-period reservoir operation problems

Tutorial (30 hours)

- 1. Methods and techniques of computation
- 2. Solution of water resources problems by numerical methods
- 3. Finite difference method
- 4. Kinematic wave model
- 5. Dynamic wave model
- 6. Method of characteristics
- 7. Simulation of groundwater flow
- 8. Optimization techniques in water resources

Practical/Assignment (15 hours)

- 1. Simulation of rainfall-runoff process in a sloped channel using the kinematic wave approximation
- 2. Model an unsteady flow scenario (e.g., gate opening or dam break) using HEC-RAS
- 3. Solution of transient flow problem (e.g., sudden valve closure) in a pipeline using the Method of Characteristics (MOC) in MATLAB or Python

4. Development of MATLAB or Python program to solve 1D steady-state groundwater flow in a confined aquifer using the finite difference method (FDM) with Dirichlet boundary conditions
5. Creation of 2D steady-state groundwater model to simulate seepage under an earthen dam using MODFLOW and ModelMuse GUI
6. Formulation of linear programming model to optimize the monthly operation of a single reservoir for irrigation and hydropower using Excel Solver or Python

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	8
2	9	12
3	12	16
4	9	12
5	9	12
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Cheng, A. H.-D., Cheng, D. T. (2005). Applied Hydrology with Remote Sensing. Springer.
2. Anderson, M. P., Woessner, W. W. (1992). Applied Groundwater Modeling: Simulation of Flow and Advective Transport. Academic Press.
3. Chapra, S. C., Canale, R. P. (2015). Numerical Methods for Engineers. McGraw-Hill.
4. Loucks, D. P., van Beek, E. (2017). Water Resource Systems Planning and Management: An Introduction to Methods, Models, and Applications. Springer.
5. Wurbs, R. A., James, W. P. (2002). Water Resources Engineering. Prentice Hall.
6. Chaudhry, M. Hanif. (2008). Open-Channel Flow. Springer.
7. Chow, Ven Te. (1988). Applied Hydrology. McGraw-Hill.

TRANSPORTATION PLANNING AND MODELING

ENCE 371

Lecture : 3

Year : III

Tutorial : 2

Part : II

Practical : 1

Course Objectives:

The objective of this course is to provide students principles of transportation planning and the use of mathematical models for transport demand forecasting. It covers the role and functions of models in system analysis, the different types of models and their applications. It emphasizes on aggregated models for trip generation, trip distribution, modal split, and network assignment, along with estimation of model parameters with calibration, enabling student to analyze and forecast transportation demand effectively.

1 Introduction (7 hours)

- 1.1 Concept of transportation planning
- 1.2 Existing planning process in Nepal
- 1.3 Rational decision-making process
- 1.4 System engineering concept and application in transport planning
- 1.5 Models and model developing process
- 1.6 Issues in transportation planning and modeling

2 Statistics in Transportation Planning (7 hours)

- 2.1 Statistics in transportation (Binomial, Poisson, negative binomial, negative exponential and normal distributions)
- 2.2 Hypothesis tests
- 2.3 Regression analysis

3 Transportation Survey (4 hours)

- 3.1 Basic sampling theory
- 3.2 Data collection methods in transportation
- 3.3 Home interview survey
- 3.4 Roadside interview survey
- 3.5 Inventory of transport facilities, land-use and economic activities
- 3.6 Network and zoning system

4 Traffic Forecasting (6 hours)

- 4.1 Need for traffic forecasting
- 4.2 Forecasting based on past trends

- 4.3 Mathematical models for traffic forecasting
- 4.4 Econometric method for traffic forecasting
- 4.5 Land use forecasting model (Lowry model)

5 Trip Generation Modeling (5 hours)

- 5.1 Trip classification
- 5.2 Concept of trip generation and factors affecting trip generation
- 5.3 Trip generation analysis: Growth factor modeling; Regression analysis; Category analysis

6 Trip Distribution Modeling (6 hours)

- 6.1 Concept of trip distribution and factors affecting trip distribution
- 6.2 Growth factor methods: Uniform; Average growth factor; Fratar method; Furness method
- 6.3 Gravity models

7 Modal Split Model (4 hours)

- 7.1 Concept of mode choice modeling and factors affecting mode choice
- 7.2 Types of modal split models; Logit model and its application

8 Trip Assignment (6 hours)

- 8.1 Basic concepts and factors affecting trip assignment
- 8.2 Procedure of trip assignment (Minimum path technique; Minimum path with capacity restraint; BPR Method; Diversion curves; User equilibrium assignment; System optimization assignment)

Tutorial (30 hours)

- 1. Use of probability distributions and regression analysis
- 2. Sampling theory and estimation of sample size
- 3. Analysis of trip generation
- 4. Analysis of trip distribution
- 5. Application of modal split model
- 6. Trip assignment

Practical/Assignment (15 hours)

- 1. Review of previous transportation study reports
- 2. Application of geo-informatics in transportation planning
- 3. Traffic and transport study using recent macro simulation packages

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	8
2	7	8
3	4	6
4	6	8
5	5	8
6	6	8
7	4	6
8	6	8
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Kadiyali, L. R. (2024). Traffic engineering and transport planning. Khanna Publishers.
2. Papacostas, C. S., Prevedouros, P. D. (2000). Transportation engineering and planning. Pearson.
3. Meyer, M. D., Miller, E. J. (2001). Urban transportation planning: A decision-oriented approach. McGraw-Hill.
4. Ortúzar, J. de D., Willumsen, L. G. (2024). Modelling transport. John Wiley & Sons.

RAILWAY ENGINEERING

ENCE 372

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to provide basic knowledge of railway engineering, covering the key components, design principles of railway track and geometry, signal systems and train control mechanisms, and operational aspects of railway systems. It aims to equip students with the technical understanding necessary for planning, designing, and managing railway infrastructure and operations.

- 1 Introduction (4 hours)**
 - 1.1 History of railways
 - 1.2 Characteristics of railways
 - 1.3 Classification of railways
 - 1.4 Advantages of railways
 - 1.5 Scope and development of railways in Nepal
- 2 Train Resistance and Rolling Stock (5 hours)**
 - 2.1 Train resistances and tractive effort
 - 2.2 Rolling stock
 - 2.3 Locomotives (Definition, types and essential parts)
 - 2.4 Coaches and wagons
 - 2.5 Train braking system
- 3 Railway Track (5 hours)**
 - 3.1 Definition of track gauge and its types
 - 3.2 Types of gauges used in different countries
 - 3.3 Permanent way and its requirements
 - 3.4 Functions and requirements of ideal rails
 - 3.5 Types of rails
 - 3.6 Rail wear and methods to reduce
- 4 Sleepers (4 hours)**
 - 4.1 Functions of sleepers
 - 4.2 Types of sleepers
 - 4.3 Requirements of an ideal material for sleepers
 - 4.4 Materials for cross-sleepers

- 5 Ballast (4 hours)**
- 5.1 Functions and Ideal requirements of ballast
 - 5.2 Types of ballast
 - 5.3 Ballast-less track
- 6 Rail Fastenings (4 hours)**
- 6.1 Rail joints
 - 6.2 Avoidance of rail joints
 - 6.3 Types of rail joints
 - 6.4 Fish-plates
 - 6.5 Rail welding
- 7 Geometric Design of Railway Track (8 hours)**
- 7.1 Objections to track curvature
 - 7.2 Designation of a curve
 - 7.3 Types of curves and limiting radius or degree of curvature
 - 7.4 Design of transition curves
 - 7.5 Super elevation and negative super elevation
 - 7.6 Different types of speed of trains on curves
 - 7.7 Design of vertical alignment
 - 7.8 Grade compensation on curves
 - 7.9 Bending of rails on curves
- 8 Stations and Yards (6 hours)**
- 8.1 Definition and purposes of a railway station
 - 8.2 Site selection for a railway station
 - 8.3 Key features of a railway station
 - 8.4 Types of stations
 - 8.5 Platforms
 - 8.6 Railway yard and types
 - 8.7 Level crossings
- 9 Signaling (5 hours)**
- 9.1 Definition and objectives of railway signaling
 - 9.2 Types of signals
 - 9.2.1 Classification according to function
 - 9.2.2 Classification according to location
 - 9.2.3 Special signals
 - 9.3 Modern signaling systems
 - 9.4 Typical signal layouts
 - 9.5 Train movement control
 - 9.6 Railway telecommunication

Tutorial**(30 hours)**

1. Geometric design of a railway track
2. Design of railway track structure
3. Designation of a railway curve
4. Design of curves (Limiting radius or degree of curvature)
5. Design of transition curves
6. Design of super elevation and negative super elevation
7. Design speed of trains on curves
8. Design of vertical alignment
9. Grade compensation on curves

Practical/Assignment**(15 hours)**

1. Visual presentation/demonstration/observation of components of railways
2. Individual assignment with report submission on “Planning and design of a railway track alignment with components for a selected area of Nepal”

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

* There may be minor deviation in marks distribution.

References

1. Profillidis, V. A. (2006). Railway management and engineering. Ashgate Publishing.
2. Mundrey, J. S. (2009). Railway track engineering. Tata McGraw-Hill.
3. Bonnett, C. F. (2005). Practical Railway Engineering. Imperial College Press.
4. Chandra, S., Agarwal, M. M. (2013). Railway Engineering. Oxford University Press.
5. Rangwala, S. C. (2012). Railway engineering. Charotar Publishing House.

ROCK MECHANICS AND ENGINEERING

ENCE 373

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to provide students the knowledge of overall behavior of rocks and rock masses and the safe and economic designs of excavation and embankments in hilly areas. It delivers to determine the slope sensitivity to different triggering mechanism and to test and compare different support and stabilization options. At the end of this course students will be able to acquire basics of analysis and design of tunnels, caverns, slopes, and foundations on rocks.

1 Rock Engineering and Its Development (4 hours)

- 1.1 Introduction and basic concepts
- 1.2 Historical perspective and uses in civil engineering
- 1.3 Rock engineering problems and application area
- 1.4 Rock engineering principles
- 1.5 Rock engineering and Nepal Himalayas scenario

2 Rock Properties (9 hours)

- 2.1 Rock coring and logging
- 2.2 Physical properties
- 2.3 Mechanical properties
- 2.4 Failure in rocks: Hydrostatic compression; Deviatoric compression and effect of confining pressure
- 2.5 Failure modes in rocks; Complete stress-strain curve
- 2.6 Failure criteria for rocks; Mohr-coulomb criterion; Effect of water pressure and principle stress ratio; Hoek and Brown criterion; Empirical Rock failure criterion; Griffith failure criterion; Hyperbolic model and Bieniawski-Yudhbir criterion
- 2.7 Weakness joint and faults

3 Stresses around Underground Openings (8 hours)

- 3.1 Origin of rock stress
- 3.2 Stresses surrounding underground opening, Kirsch equation
- 3.3 Circular hole in an elasto-plastic infinite medium under hydrostatic loading
- 3.4 Plastic behavior around tunnels; Zone of influence

- 3.5 Excavation shape and boundary stress
- 3.6 Stress distribution due to development of fractured zone
- 3.7 Tunneling in stratified rock and blocky rock
- 3.8 Rock fractures and scale/size effect
- 3.9 Numerical modelling for stresses around underground opening
- 3.10 Effect of width to height (W/H) ratio
- 3.11 Tunneling in weak rock
- 3.12 Effects of planes of weakness on stress distribution

4 Tests on Rock and Rock Masses (5 hours)

- 4.1 Tests on rock: Uniaxial, tensile, point load, triaxial and direct shear test
- 4.2 In-situ direct shear test
- 4.3 In-situ tests for deformability (Plate, uniaxial and pressure meter test)
- 4.4 In-situ stress and their determination (Hydraulic, fracture and stress relief)
- 4.5 Geophysical investigation

5 Groundwater in Rock Masses (4 hours)

- 5.1 Permeability and hydraulic conductivity
- 5.2 Estimation of water leakages
- 5.3 Groundwater effects on slope stability
- 5.4 Groundwater pressure models
- 5.5 Problems caused by water

6 Geological Investigation for Underground Structures (4 hours)

- 6.1 Scope and importance
- 6.2 Investigation stages
- 6.3 Pre-construction phase investigations
- 6.4 Construction phase investigations
- 6.5 The engineering geological report

7 Rock Mass Classification and Improvement of Rock Mass (6 hours)

- 7.1 The RMR system, Q-system, GSI system and RMI system of classifications
- 7.2 Correlation between RMR, Q and GSI values
- 7.3 Rock reinforcement, rock bolting-suspension, beam building and keying theory
- 7.4 Underground supports
- 7.5 Evaluation of support requirements

8 Rock Engineering and its Applications in Slope Stability (5 hours)

- 8.1 Importance of rock slope stability in Nepal (Himalayan geology, fragile mountains, major incidents in the Himalayas, infrastructure needs)
- 8.2 Roadside slopes stability

- 8.3 Slopes around dams, tunnels, and reservoirs
- 8.4 Stone quarry and mining-related slope failures
- 8.5 Lessons from recent earthquakes
- 8.6 Engineering best practice for Nepalese terrain

Tutorial

(30 hours)

1. Analysis of stress distribution around underground openings for structural stability assessment
2. Quantitative estimation of water leakage in rock masses using permeability and flow models
3. Graphical analysis of geological data using joint rosettes, rose diagrams, and stereonets
4. Interpretation of joint patterns and failure modes for slope and tunnel design
5. Stress analysis around underground openings using Kirsch equations and elasto-plastic models
6. Design of rock support systems using RMR, Q-system, and GSI-based empirical methods
7. Estimation and design of preventive measures for unstable slopes including drainage and reinforcement
8. Graphical analysis of geological data using joint rosettes, rose diagrams, and stereonets. Interpret the spatial orientation of discontinuities
9. Stress analysis around underground openings using Kirsch equations and elasto-plastic models. Assess stress concentration zones
10. Design of rock support systems using RMR, Q-system, and GSI-based empirical methods. Recommend suitable reinforcement strategies
11. Stability analysis and design of rock slopes using limit equilibrium and numerical modeling approaches; Calculation of factors of safety for various failure modes
12. Estimation and design of preventive measures for unstable slopes, including drainage systems and rock reinforcement; Optimization based on slope geometry and rock mass properties

Practical/Assignment/Observation

(15 hours)

1. Preparation and submission of a detailed report on a nearby rock engineering project by examining the practical applications of rock engineering principles and identifying the key challenges encountered during the project
2. Analysis of rock properties using available laboratory data (Uniaxial compressive strength, tensile strength, point load test); Plotting of stress-strain curves and identification of different failure types
3. Assessment of a rock slope to analyze its stability and design appropriate mitigation measures for slope stabilization

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

* There may be minor deviation in marks distribution.

References

1. Goodman, R. E. (1989). Introduction to rock mechanics (Latest Edition). John Wiley & Sons.
2. Ramamurthy, T. (2014). Engineering in rocks for slopes, foundations and tunnels. Prentice Hall India.
3. Jaeger, J.C., Cook, N.G.W., Zimmerman, R.W. (2007). Fundamentals of rock mechanics. Wiley-Blackwell.
4. Nilsen, B., Thidemann, A. (1993). Rock engineering. Norwegian Institute of Technology, Division of Hydraulic Engineering.
5. Nilsen, B., Palmström, A. (2000). Engineering geology and rock engineering (Handbook No. 2). Norwegian Group for Rock Mechanics (NBG).
6. Dhakal, B. B., Shrestha, K. P. (2023). A textbook of rock slope engineering. Heritage Publishers & Distributors

PILE FOUNDATION ENGINEERING FOR BRIDGES

ENCE 374

Lecture : 3
Tutorial : 2
Practical : 1

Year : III

Part : II

Course Objectives:

The objective of this course is to produce engineers having skills for investigation, design and construction of bridge foundation on piles. It provides understanding of soil properties and load transfer mechanisms for the structural design of piles and pile caps, and the construction aspects of pile installation. It also explores specific types of piles, design considerations for various bridge conditions, and relevant codes and standards.

1 Introduction (6 hours)

- 1.1 Classification and components of bridges
- 1.2 Types of bridge foundation
- 1.3 Topographic and river characteristics
- 1.4 Selection of pile foundation for bridges
- 1.5 Load analysis (Dead load, live load, earth pressure, impact load, seismic load, wind load and other loads)
- 1.6 Foundation design philosophy

2 Engineering Investigations and Study (6 hours)

- 2.1 Investigations and data collection at different stages of a bridge project
- 2.2 Geological and geophysical investigations
 - 2.2.1 Regional and local geology, geological structures and significance
 - 2.2.2 Geophysical investigations and types; Advantages and applications
- 2.3 Geotechnical investigation
 - 2.3.1 Field investigations (Boring, sampling, in-situ tests, ground water observation)
 - 2.3.2 Laboratory tests and data interpretation specific to pile foundation
- 2.4 Hydrological and hydraulic study for bridges
 - 2.4.1 Hydrological and hydraulic parameters for bridge design
 - 2.4.2 Estimation of design flood by suitable methods; Choice of method
 - 2.4.3 Bridge design discharge and foundation design discharge
 - 2.4.4 Linear waterway and effective linear waterway; Bridge length
 - 2.4.5 Afflux, high flood level and rating curve; Water surface profile
 - 2.4.6 Scour depth calculation by suitable methods; Depth of foundation

- 3 Geotechnical Design of Piles for Bridges (8 hours)**
- 3.1 Types of pile: Driven and bored piles, driven concrete piles, their advantages and disadvantages; Factors affecting the selection of pile type; Soil properties relevant to pile design
 - 3.2 Selection of pile materials and sizes based on load and soil conditions
 - 3.3 Load transfer mechanism: End bearing and skin friction
 - 3.4 Ultimate axial load capacity
 - 3.4.1 Single vertical pile by static method
 - 3.4.2 Single vertical pile by in-situ tests
 - 3.4.3 Pile in cohesive, cohesion less and stratified c- ϕ soil, intermediate geo-material and rock by IS and IRC code of practice
 - 3.4.4 Pile capacity by field tests
 - 3.5 Ultimate axial load capacity of under-reamed pile
 - 3.6 Group efficiency and pile group capacity
 - 3.7 Settlement of single and group piles (Consolidation, elastic and approximate methods)
 - 3.8 Analysis of laterally loaded piles: Elastic methods (Wrinkler's, p-y curve and modulus of subgrade reaction methods); Empirical and semi-empirical methods; Codal provisions
 - 3.9 Uplift capacity
 - 3.10 Negative skin friction
 - 3.11 Liquefaction and evaluation of liquefaction potential
 - 3.12 Geotechnical design considerations, design steps and requirements
- 4 Structural Design of Piles for Bridges (8 hours)**
- 4.1 Structural behavior of pile: Axial, bending and lateral resistance
 - 4.2 Design of piles for axial compression, bending and shear
 - 4.3 Spacing and arrangements for pile groups, considering interaction effects
 - 4.4 Design of pile cap ensuring adequate reinforcement and shear capacity
 - 4.5 Design of piles to resist lateral loads (Hydrodynamic, wind and seismic loads considering soil liquefaction and ground shaking)
 - 4.6 Design with down drag loads from consolidating soil layers
 - 4.7 Relevant codes and standards for pile design
 - 4.8 Structural design of pile and pile cap by limit state method
- 5 Tests on Pile (4 hours)**
- 5.1 Pile load tests and its significance
 - 5.2 Static load test (IS:2911)
 - 5.2.1 Objectives of load test, types of test
 - 5.2.2 Vertical, lateral and pull-out test, safe load, bi-directional load test
 - 5.3 Dynamic load test
 - 5.3.1 High strain dynamic test (PDA Test)); Pile integrity test
 - 5.3.2 Ultimate load from load-settlement curve by different methods

6 Construction of Piles and Pile Cap (6 hours)

- 6.1 Preconstruction planning based on filed and laboratory investigations
- 6.2 Project scheduling and monitoring tools and techniques
- 6.3 Fixing of bridge alignment and piles
- 6.4 Pile installation procedure and piling methods
 - 6.4.1 Driven pile: Driving, quality control and monitoring; Construction safety and environmental protection
 - 6.4.2 Bored pile: Boring, concreting, quality control and monitoring; Construction safety and environmental protection
- 6.5 Pile construction problems and remedial measures
- 6.6 Construction of pile cap
- 6.7 Causes of pile failure
- 6.8 Pile protection from corrosion particularly in aggressive soil environments
- 6.9 Bridge construction contract model practiced in Nepal

7 Maintenance and Rehabilitation of Bridges (7 hours)

- 7.1 Bridge maintenance
 - 7.1.1 Purpose of maintenance, cycle of maintenance
 - 7.1.2 Bridge maintenance management system, bridge components for maintenance
 - 7.1.3 Objectives, types, and time and frequency of inspection
 - 7.1.4 Prioritization of maintenance, maintenance operations
 - 7.1.5 Maintenance organization of bridge building agency in Nepal
- 7.2 Bridge rehabilitation
 - 7.2.1 Rehabilitation plan, testing methods for assessment of existing bridge
 - 7.2.2 Commonly occurred distress of foundation; Remedial measures of pile foundation; Repair and rehabilitation of damaged piles
 - 7.2.3 Methods of increasing lateral resistance and capacity of existing pile
 - 7.2.4 Bridge failure reasons and monitoring

Tutorial (30 hours)

- 1. Estimation of design flood discharge at bridge site by different methods
- 2. Estimation of waterway, high flood level, afflux and free board
- 3. Calculation of scouring discharge and depth by different methods; depth of foundation
- 4. Selection of pile materials and sizes based on load requirements and soil conditions
- 5. Determination of pile load capacity
- 6. Determination of ultimate axial load capacity of single vertical pile by static method
- 7. Determination of pile group capacity
- 8. Evaluation of liquefaction potential of soil
- 9. Bridge load analysis including dead load, live load and seismic loads

10. Design of piles for axial compression, bending and shear
11. Design of pile caps to distribute loads from the bridge structure to the piles
12. Design of piles to resist lateral loads
13. Structural design of pile and pile cap by Limit State Method

Practical/Assignment

(15 hours)

1. Visual presentation/demonstration/ observation of bridge components, soil exploration, investigations for bridge and construction of piles and pile caps
2. Individual assignment with report submission on design of pile foundation for a bridge crossing in a selected river based on hydrological and geotechnical investigations and analysis

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

* There may be minor deviation in marks distribution.

References

1. Saran, S. (2018). Analysis & design of substructures: Limit state design. Oxford & IBH Publishing.
2. Yadav T. L. (2025). Pile foundation for bridges. Setubandha.
3. Bowles, J.E. (1996). Foundation analysis and design (Latest Edition). McGraw-Hill.
4. Guo, W.D. (2024). Advanced design of pile foundations under lateral loading. CRC Press.
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6. Transportation Research Board. (2011). Design guidelines for increasing the lateral resistance of highway-bridge pile foundations by improving weak soils (NCHRP Report 697). National Academies Press.
7. Federal Highway Administration. (2005). Design and construction of driven pile foundations (FHWA-NHI-05-042, Volume I). U.S. Department of Transportation.
8. Jha, P.C., Devkota, N. (2024). A textbook of irrigation and drainage engineering. Heritage Publishers & Distributors.

EARTH HAZARD

ENCE 375

Lecture : 3

Tutorial : 2

Practical : 1

Year : III

Part : II

Course Objectives:

The objective of this course is to provide students a comprehensive understanding of earth hazards, their causes, processes, effects on infrastructure, and techniques for hazard assessment and mitigation. The course enables students to integrate earth hazard considerations into engineering design and planning.

1 Introduction (6 hours)

- 1.1 Hazard, vulnerability, risk and disaster
- 1.2 Geomorphological and geological sub-division and associated hazards
- 1.3 Key controlling factors of hazard: Geology; Climate; Hydrology; Land use patterns; Groundwater
- 1.4 Impact of earth hazards on civil engineering infrastructures

2 Geological Hazards (8 hours)

- 2.1 Earthquakes: Causes, seismic waters, magnitude and intensity
- 2.2 Earth mass movements: Classification, triggers, and mechanics
- 2.3 Soil and rock mechanics basics related to hazards

3 Hydrological Hazards (7 hours)

- 3.1 Floods: Types, causes and flood frequency analysis
- 3.2 Cryosphere hazards: Snow avalanche, glacial lakes and glacial lake outburst floods (GLOF)
- 3.3 Groundwater-related hazards: Springs, erosion

4 Atmospheric Hazards (5 hours)

- 4.1 Storms, cyclones, tornados, and hail
- 4.2 Drought: Causes and impacts
- 4.3 Climate change and its effect on hazard patterns
- 4.4 Air pollution and acid rain and their effects on structures

5 Hazard Assessment and Mapping (9 hours)

- 5.1 Remote sensing and GIS application in hazard mapping
- 5.2 Hazard zonation and vulnerability mapping

- 5.3 Hazard modelling and prediction tools
- 5.4 Multi-hazard risk assessment methods

6 Hazard Mitigation and Management (10 hours)

- 6.1 Engineering approaches: Slope stabilization, retaining structures, drainage
- 6.2 Bioengineering and natural methods of hazard control
- 6.3 Multi-hazard early warning systems (EWS) and disaster preparedness
- 6.4 Policy, planning and community involvement in hazard management

Tutorial (30 hours)

- 1. Analysis of relationship between geological, climatic, and land-use factors to determine hazard, vulnerability and risk in a selected area of Himalaya
- 2. Flood frequency analysis to estimate flood risk in a selected river basin
- 3. Evaluation of causes and impacts of drought in Nepal and propose mitigation strategies based on climatic and agricultural data
- 4. Application of GIS tools to create a hazard zonation map identifying areas of varying vulnerability to earth hazards
- 5. Design of a comprehensive slope stabilization and EWS plan for landslide-prone regions integrating engineering and community-based approaches

Practical (15 hours)

- 1. Analysis of spatial distribution of landslide occurrences in Nepal Himalaya using GIS data and correlate with geological and climatic factors
- 2. Evaluation of seismic hazard by analyzing ground shaking intensity maps and historic earthquake catalogs for a Nepalese region
- 3. Execution of statistical frequency analysis of historical landslide-triggering rainfall events to determine rainfall thresholds for slope failure
- 4. Application of remote sensing and GIS to create a multi-hazard zonation map highlighting earthquake, landslide, and flood-prone areas
- 5. Review of engineering case studies of slope stabilization structures and model their performance under different geotechnical conditions

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

* There may be minor deviation in marks distribution.

References

1. Deoja, B., Dhital, M., Thapa, B. (1990). Mountain risk engineering handbook, Vol. 1 and 2. ICIMOD.
2. Department of Roads. (1996). Bioengineering for road engineers' training module, Vol. 1 and 2. DOR/HMG.
3. Keller, E. A., DeVecchio, D. E. (2011). Natural hazards: Earth's processes as hazards, disasters, and catastrophes (4th ed.). Pearson.
4. Bajracharya, S. R., Mool, P. K., Shrestha, F. (2007). Glacier lakes and glacial lake outburst floods (GLOFs). ICIMOD.
5. Kalvoda, J., Novotná, E. (Eds.). (2024). The nature of geomorphological hazards in the Nepal Himalaya. Springer.
6. Luirei, K., Rastogi, B. K. (Eds.). (2023). Natural hazards and risk mitigation. Springer.
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8. Jha, P. C., Devkota, N. (2024). Irrigation and drainage engineering (3rd ed.). Heritage Publishers and Distributors.

BIOENGINEERING

ENCE 376

Lecture : 3
Tutorial : 2
Practical : 1

Year : III

Part : II

Course Objectives:

The objective of this course is to provide students with comprehensive knowledge of vegetation types, their functions, and integration with small scale civil engineering structures for landslide protection, mitigation, and management. By the end of the course, students will be able to assess and investigate landslide and plan, design, and implement appropriate bioengineering measures for slope stabilization.

- 1 Introduction (4 hours)**
 - 1.1 Landslides and soil erosion scenario in Nepal
 - 1.2 Conventional approaches for slope protection and stabilization and their engineering functions
 - 1.3 Vegetation as a slope stabilizing material and its engineering functions
 - 1.4 Scope, advantages, limitations and sustainability of bioengineering techniques
- 2 Mass Movement (6 hours)**
 - 2.1 Mass movements and its classification
 - 2.2 Erosion: Types, causes and effects
 - 2.3 Landslides: Types, causes (Geological, geomorphological, topographical, anthropogenic) and their impacts
 - 2.4 Landslide triggers; Rainfall induced landslides
 - 2.5 Landslide assessments and investigations
 - 2.6 Landslide mapping, assessment of seriousness, and repair priorities
- 3 Vegetation: Structure, Propagation and Function (10 hours)**
 - 3.1 Plant types, forms, and structures
 - 3.2 Plant community
 - 3.3 Basic plant requirements
 - 3.4 Plant propagation: Sexual and asexual methods
 - 3.5 Distribution of plants in Nepal
 - 3.6 Hydrological and hydraulic functions of vegetation
 - 3.7 Engineering functions of vegetation
 - 3.8 Slope stability by vegetation
 - 3.8.1 Soil root model: Principles and derivation

- 3.8.2 Different root architecture and their impact on slope stability
- 3.9 Environmental functions

4 Vegetative Techniques (10 hours)

- 4.1 Classification of vegetative systems: Based on plant types, propagation, and purpose
- 4.2 Design consideration of major vegetative techniques
 - 4.2.1 Grass seeding and plantation
 - 4.2.2 Bamboo plantation
 - 4.2.3 Shrubs and tree seeding and plantation
 - 4.2.4 Cuttings based techniques: Brush-layering, palisades, fascines, checkdams
 - 4.2.5 Other methods: Jute net and grass plantation, live crib wall, vegetated riprap
- 4.3 Species selection
 - 4.3.1 Site categorization: Topographic, slope material, climatic
 - 4.3.2 Native vs exotic species
 - 4.3.3 Socio-economic consideration
 - 4.3.4 Drought factor
- 4.4 Selection of optimal vegetative technique

5 Civil Engineering Techniques (10 hours)

- 5.1 Conventional and emerging techniques
- 5.2 Small scale civil engineering systems, their selection and design considerations
 - 5.2.1 Slope work
 - 5.2.2 Retaining, revetment, dentition, frame, crib walls
 - 5.2.3 Check dams
 - 5.2.4 Surface and sub-surface drainage; Drainage network planning
 - 5.2.5 Cross-drainage and energy dissipation structures
- 5.3 Integration of vegetative and civil engineering systems

6 Nursery (3 hours)

- 6.1 Nursery and its components
- 6.2 Site selection and components design
- 6.3 Materials are resources
- 6.4 Nursery management

7 Bioengineering Implementation and Management (2 hours)

- 7.1 Cost estimation: Quantity estimation and rate analysis
- 7.2 Seasonal planning of bioengineering systems
- 7.3 Maintenance, monitoring and performance evaluation

Tutorial**(30 hours)**

1. Preparation landslide investigation planning for a given case
2. Landslide mapping and hazard zonation
3. Evaluation of soil reinforcement model for grass-based systems
4. Evaluation of soil reinforcement model for shrub- based systems
5. Evaluation of soil reinforcement model for Tree- based systems
6. Design of vegetative systems
7. Design of retaining/revetment walls
8. Design of drainage system for a landslide mitigation

Practical**(15 hours)**

1. Visual presentation/demonstration/observation of species identification, site assessment/investigation and real-case observation and data collection
2. Design of landslide mitigation with vegetative and civil engineering systems
3. Preparation of drawing, cost estimation and implementation plan

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

* There may be minor deviation in marks distribution.

References

1. Department of Roads. (1999). Roadside bio-engineering: Reference manual and Site handbook. Government of Nepal.
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4. International Centre for Integrated Mountain Development. (1991). Mountain risk engineering handbook.
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INTEGRATED SOLID WASTE MANAGEMENT

ENCE 377

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to provide comprehensive understanding of solid waste management, including the properties of different waste types, key considerations, and evaluation of emerging wastes. Students will be able to analyze and manage municipal solid waste operations, encompassing collection, transfer systems, and landfills, while applying fundamental technologies to ensure environmentally sound practices. Additionally, students will learn to classify hazardous wastes according to international standards and develop strategies for their proper management.

- 1 Introduction (4 hours)**
 - 1.1 Definition, types, and sources of solid waste
 - 1.2 Elements of solid waste management (Waste generation to disposal)
 - 1.3 Solid waste management hierarchy and guiding principles
 - 1.4 Introduction to integrated solid waste management (ISWM)
 - 1.5 Refuse, reduce, reuse, recycle and recovery (5Rs) approaches for solid waste management
 - 1.6 Solid waste management related acts, regulations, and guidelines in Nepal
 - 1.7 History and current practice of municipal solid waste management in Nepal
- 2 Waste Generation, Quantification and Characterization (4 hours)**
 - 2.1 Waste generation (Residential, commercial, institutional and industrial); Methods of quantification (Source-specific approach, materials flow methodology); Factors affecting waste generation
 - 2.2 Composition of solid waste and their characterization, sampling protocols
 - 2.3 Properties of waste: Physical properties (Specific weight, density, moisture content, particle size distribution, filled capacity, permeability of compacted waste, solid contents, porosity); Chemical properties (Ultimate analysis, proximate analysis, energy content, fusion point of ash, content of nutrients and other constituents); Biological properties and biodegradability factors
- 3 Solid Waste Collection, Storage and Transportation (6 hours)**
 - 3.1 Types of collection system: Combined waste collection system and separate waste collection system; Stationary waste collection and mobile waste collection; Public and private waste collection system

- 3.2 Collection vehicles/tools and their types: Waste storage container requirement, set out requirements, waste separation, collection equipment
- 3.3 Collection/transportation route optimization
- 3.4 Temporary storage, transfer and secondary transport system
- 3.5 Site selection and conceptual design of transfer stations: Small to medium transfer stations, large transfer station
- 3.6 Requirements of collection and transportation vehicles: Trucks and semitrailers, rail cars

4 Waste Processing Techniques (4 hours)

- 4.1 Processing methodologies and waste minimization
- 4.2 Waste segregation and waste minimization at source
- 4.3 Sorting and mechanical methods for solid waste volume reduction
- 4.4 Various methods of waste disposal: Landfills, sanitary landfills, combustors, composting

5 Land Filling Method of Solid Waste Disposal (8 hours)

- 5.1 Classification of landfills (Hazardous waste, designated waste, municipal solid waste, and uncontrolled waste disposal sites)
- 5.2 Landfill site selection and environmental considerations
- 5.3 Concept of using multi-criteria evaluation method using geographic information system (GIS) and remote sensing (RS) for Landfill Site Selection
- 5.4 Landfill design considerations and basic components
- 5.5 Formation and composition of leachate (Variation in leachate composition, movement of leachate, and leachate collection system)
- 5.6 Generation and composition of landfill gases (Principal landfill gas constituents, quantity of gas produced, variation in gas production with time)
- 5.7 Monitoring and post-closure plan (Intermediate and final landfill cover; Leachate management and control; Active and passive control of landfill gases)

6 Organic Waste Treatment Methods and Energy Recovery (6 hours)

- 6.1 Organic solid waste treatment methods: Aerobic and anaerobic; Mesophilic and thermophilic
- 6.2 Types of composting and use of compost
- 6.3 Factors affecting composting process (Nutrient and substrate; Temperature; Particle size; C/N ratio; pH level)
- 6.4 Anaerobic digestion (Biogas) methods and energy recovery
- 6.5 Advantages of co-composting and co-digestion

- 7 Thermal Treatment Methods and Energy Recovery (5 hours)**
- 7.1 High thermal treatment method: Incineration and waste to energy
 - 7.2 Advanced waste treatment methods: Gasification, pyrolysis and energy recovery
 - 7.3 Co-incineration of refuse derived fuels (RDFs)
 - 7.4 Selection of thermal treatment methods
- 8 Recycling and Resource Recovery of Solid Waste (5 hours)**
- 8.1 Principles of material recovery and recycling
 - 8.2 Informal and formal recycling of solid waste
 - 8.3 Mechanical and chemical recycling process
 - 8.4 Sorting, processing, and storage of recyclable materials
 - 8.5 Solid waste sorting and packaging system
 - 8.6 Conceptual design of material recovery facility (MRF) and solid waste sorting system
- 9 Hazardous Waste (3 hours)**
- 9.1 Introduction to hazardous waste
 - 9.2 Identification criteria for hazardous waste from solid waste
 - 9.3 Hazardous and toxicity characteristics of waste; Introduction to toxicity characteristic leaching procedure (TCLP)
 - 9.4 Classification, treatment and disposal techniques of:
 - 9.4.1 Healthcare waste
 - 9.4.2 Radioactive and waste from chemical industries
 - 9.4.3 Plastic wastes
 - 9.5 Introduction to e-waste
 - 9.6 International hazardous waste convention and national guidelines
- Tutorial (30 hours)**
- 1. Quantity calculation and material flow analysis of solid waste
 - 2. Computation method of estimating waste generation; Proximate analysis; Ultimate analysis; Approximate chemical (Energy) formula; Computation of physical properties; Energy value using Dulong's formula
 - 3. Design of optimized waste collection route for a mid-sized city considering environmental and economic factors; Computation of vehicle size, container size, number required, and location
 - 4. Design of waste management strategies including 5R for a given locality
 - 5. Sanitary land filling design criteria and design example; Numerical on gas and leachate generation; Triangular model of leachate computation
 - 6. Composting criteria and design example
 - 7. Volume reduction principles (Mechanical and thermal)
 - 8. Design example of material recovery
 - 9. Design example of central treatment facility (CTF) for healthcare waste; Recent development and practices

Practical/Assignment**(15 hours)**

1. Sampling methods and waste characterization of municipal solid waste (Ultimate and proximate analysis)
2. Determination of physical and chemical properties of municipal waste such as bulk density and moisture content in municipal solid waste
3. Determination of heating value with bomb calorimeter
4. Visual presentation/demonstration/observation of collection, transfer station and community participation practices of solid waste management of the nearest municipalities

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

* There may be minor deviation in marks distribution.

References

1. Tchobanoglous, G., Kreith, F. (2002). Handbook of solid waste management. McGraw-Hill.
2. Pichtel, J. (2014). Waste management practices: municipal, hazardous, and industrial. Taylor & Francis / CRC Press.
3. Sasikumar, K., Gopi Krishna, S. (2021). Solid waste management. New Delhi: PHI Learning Private Limited.
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ENVIRONMENTAL BIOTECHNOLOGY

ENCE 378

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to provide understanding of theory, modeling and role of environmental biotechnology in wastewater engineering. It includes knowledge of microorganisms and their kinetics use in several treatment processes. The basics of methane gas formation to nitrification and de-nitrification of waste by respective bacteria can be studied thoroughly. Emphasis is placed on practical examples and experiments to enhance students' understanding of the course content.

1 Fundamentals of Environmental Biotechnology (2 hours)

- 1.1 Introduction to biotechnology: Renewable sources and its classification
- 1.2 Role of environmental biotechnology: Scope for use
- 1.3 Importance of environmental biotechnology in environmental engineering
- 1.4 Integrated approach in environmental biotechnology

2 Microbiology (5 hours)

- 2.1 Composition and classification of microorganisms
- 2.2 Microorganisms found in surface waters and wastewater
- 2.3 Introduction to microbial metabolism; Metabolic pathways of particular relevance to environmental biotechnology
- 2.4 Bacterial growth and biomass yield
- 2.5 Microbial ecology and tools to study microbial ecology
- 2.6 Stoichiometry of biological reactions

3 Microbial Kinetics (8 hours)

- 3.1 Definitions and scope of microbial kinetics; Types of microbial growth; Kinetics terminology
- 3.2 Microbial products; Rate of utilization of soluble substrates
- 3.3 Design parameters; Applications in bioreactor design
- 3.4 Basic mass balances; Mass balance on inert bio-mass and volatile suspended solids
- 3.5 Rate of biomass growth with soluble substrate; Microbial growth kinetics and yield constant: Monod equations
- 3.6 Input of active biomass
- 3.7 Aerobic suspended growth processes

- 4 Biofilm Kinetics (8 hours)**
- 4.1 Definition, formation, and significance of biofilm
 - 4.2 The biofilm mass balance
 - 4.3 Concept of the idealized biofilm
 - 4.4 The steady state biofilm and its solutions
 - 4.5 Non-steady state biofilm
 - 4.6 Introduction to biofilm modeling, numerical modelling of biofilms; Mathematical models of biofilm growth
 - 4.7 Aerobic biofilm processes; Biofilm process configurations; Special biofilm solutions
 - 4.8 Completely mixed biofilm reactor
 - 4.9 Hybrid biofilm: Suspended growth process
 - 4.10 Granular media filters
- 5 Reactor Kinetics (8 hours)**
- 5.1 Reactors used for the treatment of wastewater: Types and application
 - 5.2 Hydraulic characteristics of reactors
 - 5.3 Factors considered in engineering design of reactors
 - 5.4 Mass balance analysis and principle (Batch, continuous flow and plug type reactors)
 - 5.5 Modeling of ideal flow in reactors: Ideal flow in complete-mix reactor and plug-flow reactor
 - 5.6 Modeling of non-ideal flow in reactors
 - 5.7 Concept of reactions, reaction rates, reaction order and reaction rate coefficients and its analysis
 - 5.8 Reactor arrangements: Reactors in series and in dispersion
 - 5.9 Linking stoichiometric and mass balance equations
 - 5.10 Process selection; Factor's affecting process selection; Process selection based on reaction kinetics; Mass transfer and loading criteria
- 6 Methanogenesis (3 hours)**
- 6.1 Use of methanogenic treatment
 - 6.2 Anaerobic membrane reactors
 - 6.3 Reactor configuration
 - 6.4 Process kinetics (Reaction kinetics for CSTR and biofilm processes)
 - 6.5 Design of anaerobic bio-solids digesters and factors affecting
 - 6.6 Design of anaerobic treatment of dilute wastewater
 - 6.7 Quantity of methane gas produced
 - 6.8 Gas collection methods and special care during gas collection

7 Nitrification and De-Nitrification

(8 hours)

- 7.1 Nitrogen forms, effects, and transformations
- 7.2 Nitrogen's transformation reactions and nitrogen cycle
- 7.3 Meaning of nitrification and de-nitrification
- 7.4 Biochemistry, physiology, and kinetics of nitrifying bacteria
- 7.5 Physiology of denitrifying bacteria, de-nitrification systems
- 7.6 Stoichiometry of biological nitrification and de-nitrification
- 7.7 Growth kinetics of biological nitrification and de-nitrification
- 7.8 Biofilm nitrification
- 7.9 Nitrous oxide formation

8 Biological Treatment of Drinking Water

(3 hours)

- 8.1 Needs of biological treatment of water
- 8.2 Treatment process reliability and selection of design values
- 8.3 Aerobic biofilm processes to eliminate biological instability
- 8.4 Anaerobic biofilm processes to reduce oxidized contaminants
- 8.5 Introduction to automatic treatment control

Tutorial

(30 hours)

1. Application of environmental biotechnology in environmental engineering
2. Classification of microorganisms and tools for the study of microbial ecology; Microorganisms found in surface water and wastewaters
3. Meaning of microbial kinetics, mass balance, design parameters, rate expressions, meaning of aerobic suspended growth processes and its uses
4. Meaning of biofilm kinetics, concept of biofilm processes, steady state biofilm, non-steady state biofilm, numerical modelling of biofilms
5. Types of reactor used in waste water treatment, factors to be considered in engineering design of reactors, modeling of ideal flow in reactors, modeling of non-ideal flows in reactors, concepts of mass balances, reactors in series
6. Use of methanogenic treatment, reactor configuration, numerical on quantity estimation of methane gas produced, and various gas collection methods
7. Meaning of nitrification and de-nitrification, physiology and kinetics of nitrifying and de-nitrifying bacteria's, concepts of growth kinetics, formation mechanisms of nitrous oxide
8. Need of biological treatment of water, treatment process reliability and selection of design values, automatic treatment control

Practical/Assignment

(15 hours)

1. Determination of biological oxygen demand (BOD) and chemical oxygen demand (COD) of any wastewater sample
2. Determination of microbial degradation of textile dyes, pesticides, hydrocarbons and oils

3. Determination and counting the colonies of E-Coli and total coliform bacteria's in any wastewater sample
4. Preparation of compost from vegetable/ leaf/ fruit wastes - Checking NPK
5. Visual presentation/demonstration/observation of working principle, operation and maintenance of the biological units of an effluent treatment plant
6. Visual presentation/demonstration/observation of the micro-organisms role in wastewater in microbiological laboratories
7. A complete modeling of waste water treatment plant showing necessary biological units and processes involved

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

* There may be minor deviation in marks distribution.

References

1. Rittmann, B.E., McCarty, P.L. (2020). Environmental biotechnology: Principles and applications. McGraw-Hill Education.
2. Evans, G., Furlong, J. (2010). Environmental biotechnology: Theory and application. Wiley-Blackwell.
3. Metcalf, L., Eddy, H. P. (2014). Wastewater engineering: Treatment and resource recovery. McGraw-Hill Education.
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AIR POLLUTION AND CONTROL

ENCE 379

Lecture : 3
Tutorial : 2
Practical : 1

Year : III
Part : II

Course Objectives:

The objective of this course is to provide fundamental knowledge about the atmosphere and air pollution, exploring the causes, effects, and impacts on public health, the environment, and climate. The course focuses on air quality standards, regulations, rules and policies; and covers control technologies and mitigation strategies. It aims to equip students with the scientific knowledge and analytical skills necessary to evaluate and design effective air pollution management solutions.

- 1 Introduction to Air Pollution (2 hours)**
 - 1.1 Definitions and classification of air pollutants
 - 1.2 Primary versus secondary pollutants
 - 1.3 Source of air pollutants: Natural and anthropogenic sources
- 2 Atmospheric Chemistry and Meteorological Process (12 hours)**
 - 2.1 Atmosphere and atmospheric chemistry
 - 2.1.1 Atmosphere and its concept
 - 2.1.2 Different layers of atmosphere
 - 2.1.3 Composition of air
 - 2.2 Atmospheric thermodynamics
 - 2.3 Atmospheric stability
 - 2.4 Effect of meteorological process on plume dispersion
 - 2.5 Inversions
 - 2.6 Air quality (AQ) modeling
 - 2.6.1 Types of AQ models
 - 2.6.2 Fixed box model
 - 2.6.3 Gaussian dispersion model
- 3 Basic Concept of Air Pollutants (4 hours)**
 - 3.1 Air pollutants
 - 3.2 Sources of pollutants
 - 3.3 Types of pollutants as per forms, class and sources
 - 3.4 Unit of measurements of different pollutants

- 4 Criteria Pollutants (7 hours)**
- 4.1 Introduction to criteria pollutants
 - 4.2 Definition, source, impacts of various criteria pollutants: CO, NO₂, SO₂, SPM, O₃, lead, hydrocarbons
 - 4.3 Introduction to atmospheric aerosols
 - 4.3.1 Definition and characteristics: Physical, chemical and biological
 - 4.3.2 Source and sinks of aerosols and forms of aerosol
 - 4.3.3 Introduction and composition of particulate matter
 - 4.3.4 Impacts of aerosol and particle removal processes
- 5 Impacts of Pollutants (6 hours)**
- 5.1 Introduction of impacts of pollution
 - 5.1.1 Health effects as acute and chronic
 - 5.1.2 Effects on vegetation, animals, materials, and visibility
 - 5.2 Climate change and air quality interlinkages
 - 5.3 Indoor air pollution and its health implications
- 6 Air Quality Standards and Monitoring (6 hours)**
- 6.1 Introduction of air control philosophies
 - 6.2 Types of air pollution control philosophies
 - 6.2.1 Emission standards
 - 6.2.2 Air quality standards: National ambient air quality standards (NAAQS); Air quality indices (AQI)
 - 6.2.3 Emission taxes
 - 6.2.4 Cost-benefit standard
 - 6.3 Introduction to "The intergovernmental panel on climate change (IPCC)"
- 7 Air Pollution Control Technologies and Air Quality Standards (8 hours)**
- 7.1 Control of particulate pollutants: Cyclones, bag filters, electrostatic precipitators, scrubbers
 - 7.2 Control of Gaseous pollutant: Absorption, adsorption, condensation, combustion, catalytic converters
 - 7.3 Ambient air quality standard
 - 7.4 Integrated air quality management
- Tutorial (30 hours)**
- 1. Effect of meteorological process on plume dispersion
 - 2. Numerical on fixed box model and Gaussian plume model for air quality modeling
 - 3. Criteria pollutants and particulate matters, their sources, impacts on environment and public health, standards, and control measures
 - 4. Greenhouse gases and its global effects on climate change

5. Global initiatives for air pollution and climate change actions, protocols and global agreements
6. Air quality standards and present context of Nepal in types, quantity, sources, measurements and control measures adopted for major pollutants

Practical

(15 hours)

1. Use of air quality monitoring instrument to determine the pollution levels
2. Visual presentation/demonstration/observation of ambient air quality monitoring stations and preparation of report on the workings and parameters that are to be measured by the instruments
3. Analysis of data of air quality monitoring stations for a short period (Over a week) and preparation of report accounting standards, impacts and recommendation of remedies

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

* There may be minor deviation in marks distribution.

References

1. De Nevers, N. (2016). Air Pollution Control Engineering. Waveland Press, Inc.
2. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. (1985). Solutions manual to accompany: environmental engineering. McGraw-Hill.
3. Environmental Protection Agency. (<https://www.epa.gov/environmental-topics/air-topics>)

ENVIRONMENTAL MONITORING AND ASSESSMENT

ENCE 380

Lecture : 3

Year : III

Tutorial : 2

Part : II

Practical : 1

Course Objectives:

The objective of this course is to develop a comprehensive understanding of the principles, methodologies, and tools used for monitoring key environmental components, including air, water, wastewater, soil, sludge, and solid waste. It aims to equip students with practical knowledge and skills in the collection, analysis, and interpretation of environmental data, enabling them to critically evaluate results, draw meaningful conclusions, and make informed decisions in environmental management and policy-making.

1 Introduction (5 hours)

- 1.1 Environmental monitoring and assessment and their needs
- 1.2 Types of environmental monitoring and their significance: Air, water, soil, waste, biodiversity, remote sensing, and enterprise monitoring
- 1.3 Objectives and benefits of environmental monitoring and assessment
- 1.4 Environmental pollution and issues, their source, effect, and prevention: Air pollution, water pollution, soil pollution, noise pollution, radioactive pollution, solid waste, flooding, droughts, forest fires, acid rain, climate change
- 1.5 Environmental pollution and issues in developing countries, environmental pollution at regional and local levels in Nepal
- 1.6 Root causes of pollution: Population, consumption, and technology
- 1.7 Environmental legislations and standards: Environmental criteria and standards, drinking water quality, surface water quality, national effluents discharge, standards, air quality standards, equipment-based and vehicular exhaust emissions standards, noise standards, legislative and constitutional provisions, environmental protection acts and regulations
- 1.8 Roles of different governmental and non-governmental agencies in preserving the environment

2 Water Quality Monitoring and Assessment (5 hours)

- 2.1 Needs for water quality monitoring, water pollution: Conventional and emerging pollutants
- 2.2 Types of water sampling, process of sampling, their prevention, factors associated with water sampling from various sources, volume of samples

- 2.3 Water quality management: Needs; Actual concentration versus desired concentrations; Extent of treatment for different uses (Domestic, industrial, recreational, and agricultural)
- 2.4 Raw water characteristics: Physical, chemical, and biological characteristics
- 2.5 Physical characteristics, parameters, and their significance (Temperature, pH, electrical conductivity, solids, turbidity); Equipment uses of and their working principles
- 2.6 Chemical characteristics: Alkalinity and acidity, their types and quantification; Hardness, their types and measurements; Organic content in wastewater (Total organic carbon, biochemical oxygen demand, quantification - principle and equipment); Chemical oxygen demand (Significance and quantification); Optimal coagulant doses and its significance
- 2.7 Biological characteristics and their significance: Types of coliform and their quantification
- 2.8 Water quality indices, needs, and importance, various WQI indices: National sanitation foundation; Canadian council of ministers of the environment water quality index; Weighted arithmetic water quality index

3 Air Quality Monitoring and Assessment (5 hours)

- 3.1 Needs for air quality monitoring and assessment; Types of air quality monitoring: Direct and indirect monitoring and their significance
- 3.2 Air pollutants measurement: Ambient and source measurements, stacks monitoring, sampling arrangements, sampling systems for particulate matters, steps involved in sampling and analysis of air pollutants
- 3.3 Gaseous sampling and its components; Ambient sampling and their system; Types of sampling and their significance (Extractive, in situ, and passive; Continuous emission monitoring system)
- 3.4 Quantification of various air quality parameters, instruments used, and their working principles: Carbon monoxide, ozone, nitrous oxides, sulfur dioxides, non-methane volatile organics and hydrocarbons, particulate matters
- 3.5 Analysis and measurement of visibility, acidic deposition and their significance
- 3.6 Measurement of other air toxics and their significance
- 3.7 Air quality indices, importance, national breakpoint values, and computation of air quality index (AQI) values

4 Soil Quality Monitoring and Assessment (5 hours)

- 4.1 Basic function of soils; Needs of soil quality monitoring; Soil quality: Innate and dynamic quality; Factors affecting soil quality; Soil health

- 4.2 Need for soil quality indicators; Soil quality index; Methods of assessment: Farmers, statistical and conventional techniques
 - 4.3 Soil sampling: Quantitative and semi quantitative measurements; Factors affecting soil sampling; Field equipment used in soil sampling; Soil samplers; Soil sampler's storage and prevention; Soil pore water sampling, samplers
 - 4.4 Soil quality parameters (Physical, chemical, and biological parameters), their measurements and significance
- 5 Municipal Solid Waste and Fecal Sludge Monitoring (5 hours)**
- 5.1 Municipal solid waste, waste generation, factors affecting waste generation
 - 5.2 Solid waste sample collection and preservation: Coning and quartering
 - 5.3 Solid waste characterization: Physical (Specific weight, particle size, and distribution, dry and wet density); Chemical (Moisture content, proximate analysis, fusing point of ash, ultimate analysis, energy content, elemental analyzer, bomb calorimeter, their working principles and uses); Biological (Organic fraction, biodegradability, odors)
 - 5.4 Faecal sludge, sample collection methods, characterization and their environmental significance
- 6 Measurement of Meteorological Parameters (5 hours)**
- 6.1 Importance, needs and applications of meteorology; Meteorological principles: Boundary layer and dynamic meteorology; Components and layers of the atmosphere
 - 6.2 Solar radiation, heat balance, transport of heat and their significance; Urban heat islands and boundaries
 - 6.3 Atmospheric circulation (Horizontal and vertical); Wind (Coriolis force, pressure gradient force, localized temperature effects)
 - 6.4 Inversions, topographical effects (Flat terrains, valleys, hills); Mountain and valley breezes
 - 6.5 Meteorological parameters (Temperature, humidity, pressure, wind speed, precipitation wind direction, mixing height, stability - atmospheric stability and their types); Their measurements, instrument used, and significance; Wind rose diagram preparation
- 7 Environmental Quality Monitoring (5 hours)**
- 7.1 Objectives and types of environmental monitoring (Source and ambient)
 - 7.2 Water quality monitoring system, purposes, and monitoring cycles
 - 7.3 Methods of field monitoring: In situ measurements, manual or automated measurements, continuous monitoring or snapshot monitoring, grab sampling, integrated depth sampling, time proportional sampling, space composite sampling, water quality kits, vacuum pumping, remote sensing, mobile monitoring network for water quality, continuous ambient air quality monitoring system and their components

- 7.4 Sampling techniques for environmental data: Simple random, stratified, systematic random sampling, cluster, multistage sampling
- 7.5 Air quality monitoring: Stationary and mobile monitoring and management, their purposes, advantages and disadvantages, national monitoring stations, criteria for selecting stationary stations
- 7.6 Design of monitoring station for air quality; Background information; Development of air quality monitoring program
- 7.7 Comprehensive environmental pollution index (CEPI) and framework for industries: Source pathway and receptor, calculation of CEPI for industries

8 Role of Remote Sensing and GIS in Environmental Monitoring (5 hours)

- 8.1 Remote sensing, principle, basic components, types and advantages
- 8.2 Application of remote sensing in air, water, soil quality monitoring and deforestation
- 8.3 Application of remote sensing in the prediction of environmental events: Snow and glacier mapping, floods, landslides
- 8.4 Geographical information system (GIS): Introduction, application of GIS in environmental monitoring data analysis of water, air and soil

9 Environmental Data Acquisition and Analysis (5 hours)

- 9.1 Objective of data acquisition and analysis, data quality
- 9.2 Errors during data analysis: Systematic and random errors, data quality control and assurance, environmental data acquisition process, data acquisition system and component, data acquisition software, advantages and disadvantages
- 9.3 Quality controls and quality assurance for environmental monitoring: Internal checks (Field blanks, lab replicates, spike samples, calibration blanks, calibration standards); External checks (External field duplicates, split samples, external labs involvements); Knowns, unknowns
- 9.4 Quality controls and assurance plans for environmental monitoring of water, air, and soil
- 9.5 Data quality objective processes; Basic statistics (Descriptive, graphical, probabilistic statistics in environmental monitoring); Statistical errors and types

Tutorial (30 hours)

1. Study of environmental pollution at regional and local levels in Nepal; Use of national environmental legislations
2. Numerical on pH, alkalinity, BOD and determination of water quality index (WQI); Methods of water sampling
3. Sampling and analysis of air pollutants; National ambient air quality standards; Computation of air quality indices (AQI) values
4. Monitoring of soil quality; Study of field equipment for soil sampling; Measurement of soil quality parameters

5. Quantity estimation of municipal solid waste; Development of chemical formula; Energy estimation using empirical formulae (Dulong's equation, Khan formula); Methods of sample collection of fecal sludge; Collection and preservation of solid waste
6. Numerical on developing wind rose diagram
7. Environmental monitoring; Study of sampling techniques for measuring environmental data; Methods of water and air quality monitoring systems
8. Application of remote sensing in quality monitoring of air, water, soil, deforestation and use of GIS in environmental monitoring data analysis of water, air and soil
9. Use of data acquisition software, quality controls and assurance plans for environmental monitoring of water, air and soil

Practical/Assignment

(15 hours)

1. Sampling and characterization of water samples for various parameters
2. Sampling of soils and characterization for various parameters
3. CEPI assessment for an industry of nearby locations
4. Design of station for surface water and air quality monitoring systems at nearby localities and development of monitoring plans in accordance with national legislation
5. Visual presentation/demonstration/observation of monitoring stations of air and water quality; Meteorological station

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

* There may be minor deviation in marks distribution.

References

1. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C. (1994). Fundamentals of air pollution (Latest Edition). Academic Press.
2. Manly, B.F.J. (2008). Statistics for environmental science and management. Chapman & Hall/CRC.

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7. Sawyer, C.N., McCarty, P.L., Parkin, G.F. (1994). Chemistry for environmental engineering (Latest Edition). McGraw-Hill.
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9. American Public Health Association. (2017). Standard methods for the examination of water and wastewater. American Public Health A.



YEAR IV

Final year

IOE has named these courses in the curriculum structure but has not yet published their syllabi. They will be added to this handbook once released.

Semester 7 YEAR IV, PART I

ENCE 401	Operations Research	Awaiting IOE
ENCE 402	Project and Construction Engineering	Awaiting IOE
ENCE 403	Hydropower Engineering	Awaiting IOE
ENCE 411-434	Elective II	Awaiting IOE
ENCE 435-449	Elective III	Awaiting IOE
ENCE 404	Project I	Awaiting IOE

Semester 8 YEAR IV, PART II

ENCE 461	Project II	Awaiting IOE
ENCE 462	Internship	Awaiting IOE

IV



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