DESIGN OF TIMBER AND MASONRY STRUCTURES

ENCE 301

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 0

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 **Year : III**
Tutorial : 2 **Part : I**
Practical : 1

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 ($Ø_u$=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, Meyorhof, 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 **Year : III**
Tutorial : 1 **Part : I**
Practical : 0

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 **Year : III**
Tutorial : 2 **Part : I**
Practical : 1

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 **Year : III**
Tutorial : 2 **Part : I**
Practical : 1

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 Feacal 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 Feacal 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 feacal 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

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ENGINEERING HYDROLOGY

ENCE 306

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

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 Infiltrometers
  3.4.2 Infiltration models: Horton; Introduction to Kostiakov, 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

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ENGINEERING ECONOMICS

ENCE 307

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 0

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.
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