

BUILDING SCIENCE II

ENAR 252

Lecture : 3
Tutorial : 1
Practical : 0

Year : II
Part : II

Course Objectives:

The objective of this course is to provide fundamental concept of architectural lighting, acoustics and energy in relation to architectural design. It equips students with tools for providing comfort and security in building in relation to lighting, acoustics and energy.

1 Architectural Acoustics (2 hours)

- 1.1 Introduction and importance of architectural acoustics
- 1.2 History of architectural acoustics
- 1.3 Ancient open air theatre: Dabali of Nepal, Greek and Roman

2 Properties Acoustics (2 hours)

- 2.1 Fundamental of architectural acoustics
- 2.2 Sound properties and its reaction
- 2.3 Classification of sound (Air borne and impact)
- 2.4 Measure of sound intensity level, audible range of sound
- 2.5 Acceptable indoor noise level

3 Room Acoustics (4 hours)

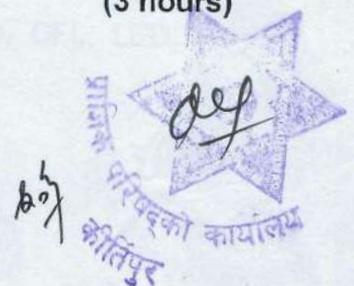
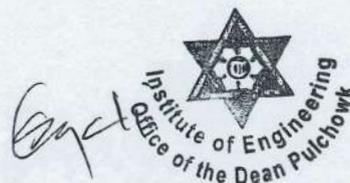
- 3.1 Three reactions of sound in an enclose space
- 3.2 Mass law, vertical and horizontal barrier
- 3.3 Transmission loss, sound insulation
- 3.4 Common acoustic problems in a room: Echo, reverberation, sound foci, dead spots, insufficient loudness, external noise

4 Acoustical Materials (2 hours)

- 4.1 Absorption and reflection of materials
- 4.2 Types of acoustical materials: Prefabricated units, acoustical plaster and sprayed, acoustical blankets

5 Reverberation Time (3 hours)

- 5.1 Reverberation time



- 5.2 The Sabine-Eyring reverberation time equation
- 5.3 Calculation of optimum reverberation time (ORT)

6 Acoustical Design of an Auditorium (4 hours)

- 6.1 Auditorium, types of auditoriums
- 6.2 Requirements of good acoustics design in auditorium
- 6.3 Factors affecting acoustic design of an auditorium: Site selection and planning, shape and size, audience seating, treatment of interior surfaces, sound path and reverberation time
- 6.4 Sound reinforcement systems: Objectives, components and specifications (input devices, amplifier and controls, loudspeakers)

7 Noise Control (4 hours)

- 7.1 Noise and its types
- 7.2 Impact of noise to human beings
- 7.3 Noise control techniques
- 7.4 Noise control techniques for external noise: Urban planning according to noise level, orientation, planning and design of a building, noise screening (Natural and artificial, noise reduction by construction technology)
- 7.5 Noise control for internal noise

8 Architectural Lighting (4 hours)

- 8.1 Importance of architectural lighting
- 8.2 History of architectural lighting
- 8.3 Light, properties of daylight
- 8.4 Photometric quantities of light
- 8.5 Daylight factor, design sky concept
- 8.6 Light and glare

9 Daylight in Buildings (4 hours)

- 9.1 Objectives of day lighting in a building
- 9.2 Building shape and layout
- 9.3 Location, shape and size of openings
- 9.4 Orientation of buildings

10 Artificial Lighting in Buildings (6 hours)

- 10.1 Objectives of artificial lighting in a building
- 10.2 Electric light sources: Incandescent lamp, fluorescent lamp, CFL, LED, high-intensity discharge lamps, smart lighting



- 10.3 Interior lighting design
- 10.4 Introduction and types of interior lighting system: Direct, indirect, semi-direct, semi-indirect, diffused
- 10.5 Illumination design and calculation

11 Architecture Lighting Philosophy (2 hours)

- 11.1 Introduction to architectural lighting philosophy
- 11.2 Architectural lighting master pieces of Le Corbusier, Louis I. Kahn and Tadao Ando

12 Energy (8 hours)

- 12.1 Energy and its concepts
- 12.2 Sources of energy: Renewable and nonrenewable energy
- 12.3 Global energy scenario
- 12.4 Energy scenario in Nepal
- 12.5 Passive methods of energy conversion
- 12.6 Orientation, planning, color, texture, materials, technology
- 12.7 Direct, indirect and isolated gain
- 12.8 Active methods of energy conversion
- 12.9 PV cell, solar collector, solar water heater, dryer

Tutorial (15 hours)

1. Calculation of reverberation time of a hall
2. Acoustic design in a selected building (Observation, study and analysis)
3. Design and calculation of artificial illumination in a room
4. Day lighting and artificial lighting design in a selected building (Observation, study 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*
1,2	4	6
3,4	6	6
5,6	7	12
7	4	6
8,9	8	12
10,11	8	6
12	8	12
Total	45	60

* There may be minor deviation in marks distribution.

References



1. Koenigsberger, O.H. Ingersoll, T.G., Mayhew, A. (2020), "Manual of Tropical Housing and Building" – Universities Press (India) Private Limited.
2. David, M.E. (1972), "Concepts in Architectural Acoustics", McGraw Hill book company, USA
3. Salvan G.S. (1999), "Architectural Utilities 3 - Lighting and Acoustics", JMC Press Inc, Quezon City
4. Barron, M. (2010), "Auditorium Acoustics and Architectural Design", Taylor & Francis, London and New York
5. Punmia, B.C. (2005), "Building Construction", Laxmi Publication, New Delhi, India.

Architectural Acoustics (2 hours)

- 1.1 Introduction and importance of architectural acoustics
- 1.2 Modes of architectural acoustics
 - 1.2.1 Auditorium, hall or theatre - Absorption, Load, Green and Floran

Properties Acoustics (2 hours)

- 2.1 Fundamentals of architectural acoustics
- 2.2 Sound characteristics and its relation
- 2.3 Characteristics of sound (Pitch, Loudness and timbre)
- 2.4 Measure of sound intensity and audible range of sound
- 2.5 Acoustical index and noise level

Room Acoustics (4 hours)

- 3.1 Time characteristics of sound in enclosed spaces
- 3.2 Sound field: natural and artificial sound
- 3.3 Reverberation time, Sabine equation
- 3.4 Criteria for acoustic environment in a room: Echo, reverberation, sound field and noise, multichannel acoustics, virtual reality

Acoustical Materials (2 hours)

- 4.1 Absorption and reflection of sound waves
- 4.2 Types of acoustical materials: Porous, fibrous, panel, cavity, resonant, bimaterial

Measurement Time



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BUILDING TECHNOLOGY

ENCE 255

Lecture : 2
Tutorial : 2
Practical : 0

Year : II
Part : II

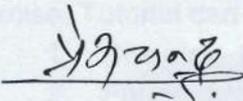
Course Objectives:

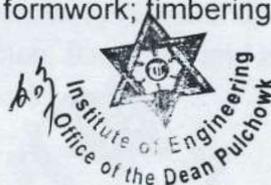
To introduce functional requirement of building, its component, special work, special treatment in building and sustainable building

- 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 refiling 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

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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	Mark 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

Signature



CONTROL SYSTEM

ENEE 251

Lecture : 3
Tutorial : 1
Practical : 3/2

Year : II
Part : II

Course Objectives:

This course aims to provide foundational knowledge in control system analysis and design. It introduces essential concepts needed to understand and create control systems. Students will learn to model and analyze control mechanisms. The course emphasizes applying these principles to real-world physical processes.

- 1 Control System Background (2 hours)**
 - 1.1 History of control system and its importance
 - 1.2 Control system: Definition, Characteristics and basic features, Components and variables
 - 1.3 Types of control system and their comparison

- 2 Component Modeling (6 hours)**
 - 2.1 Differential equation and transfer function, Characteristics equation, concept of pole and zero
 - 2.2 Modeling of mechanical system (linear and rotational)
 - 2.3 Modeling of electrical components: Inductance, capacitance, resistance, DC and AC motor, transducers and operational amplifiers, electric circuit and transfer function
 - 2.4 Mechanical to electrical analogy: Force-voltage and force-current
 - 2.5 Linearized approximations of non-linear characteristics

- 3 System Transfer Function and Responses (10 hours)**
 - 3.1 Block diagram modelling and reduction techniques
 - 3.2 Signal flow graphs and mason's gain formula
 - 3.3 Time response analysis
 - 3.3.1 Types of test signals: Impulse, step, ramp, parabolic
 - 3.3.2 Time response analysis of first order system
 - 3.3.3 Time response analysis of second order system (Step)
 - 3.3.4 Time response specifications: Rise time, peak time, delay time, settling time and maximum overshoot and steady state error
 - 3.4 Static error coefficients and steady state error
 - 3.5 P, PI, PD, PID controller and derivative feedback controller

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- 4 **Stability** (4 hours)
- 4.1 Introduction of stability and causes of instability
 - 4.2 Characteristic equation, root location and stability
 - 4.3 R-H stability criterion and application
 - 4.4 Relative stability analysis from complex plane axis shifting
- 5 **Root Locus Technique** (6 hours)
- 5.1 Introduction of root locus
 - 5.2 Relationship between root loci and time response of systems
 - 5.3 Rules for manual calculation and construction of root locus
 - 5.4 Stability concept from Root Locus
- 6 **Frequency Response Techniques** (8 hours)
- 6.1 Frequency domain characterization of the system
 - 6.2 Relationship between real and complex frequency response
 - 6.3 Polar Plot
 - 6.4 Stability analysis in Frequency Domain: Gain Margin, Phase Margin
 - 6.5 Nyquist Plot and Criterion for stability analysis
 - 6.6 Bode Plot: Significance of Bode Plot, Magnitude and Phase Plot
 - 6.7 Stability analysis from Bode plot
- 7 **Performance Specifications and Compensation Design** (6 hours)
- 7.1 Compensation technique and compensators
 - 7.2 Application of root locus and frequency response on control system design
 - 7.3 Lead compensator and lag compensator design from:
 - 7.3.1 Root locus method
 - 7.3.2 Bode plot method
 - 7.4 Concept of Lead-lag compensator
- 8 **State Space Analysis** (3 hours)
- 8.1 Definition of state-space, state variables and state vector
 - 8.2 State space representation of electrical and mechanical system
 - 8.3 State space from differential equations
 - 8.4 Conversion from transfer function to state space
 - 8.5 Conversion from state space to a transfer function
 - 8.6 State-transition matrix
- Tutorial** (15 hours)
- 1. Modeling exercises of Mechanical/Electrical System and analogy
 - 2. Block diagram model development and reduction, SFG exercise
 - 3. Time response exercise of first order and second order system and steady state error and PID
 - 4. RH criterion and relative stability numerical, root locus plot

Boad



5. Polar and Nyquist Plot, Bode plotting and stability analysis in frequency domain
6. Compensator design exercises from Root locus and Bode Plot approach for Lead and Lag Compensator
7. State space model development exercises from differential equation, transfer function model and vice versa and Stability check

Practical

(22.5 hours)

1. To study open loop and closed mode for DC motor and familiarization with different components in DC motor control module.
2. To determine gain and transfer function of different control system components
3. To study effects of feedback on gain and time constant for closed loop speed control system and position control system
4. To determine frequency response of first order and second order system and to get transfer function
5. Simulation of closed loop speed control system and position control system and verification

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

* There may be minor deviation in marks distribution.

References

1. Ogata, K. (2009). Modern Control Engineering. (5th edition). Pearson
2. Gopal, M. (2009). Control Systems: Principles and Design. (4th edition). Tata McGraw-Hill.
3. Kuo, B. C. (2015). Automatic Control System (9th ed.). Willey India.
4. Nagrath, I. J., & Gopal, M. (2021) Modern Control Engineering. (7th edition) New Age International.
5. Hassan, S. (2013). Automatic Control System. (Reprint 2013). Arihant

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DESIGN STUDIO IV

ENAR 251

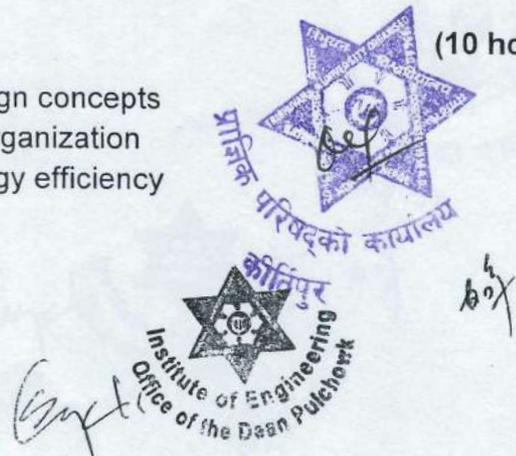
Lecture : 0
Tutorial : 0
Practical/Studio : 10

Year : II
Part : II

Course Objectives:

This course equips students to design climate-adaptive structures that integrate local architectural principles and contextual influences. The objective is to develop skills in designing buildings, such as climate-sensitive homes, cultural centers, and small public facilities, like high school, community library, college with a user-centered and environmentally responsive approach. The studio focuses on applying knowledge from the building science course, supported by previous and current coursework, to explore concepts, and develop construction details to create culturally resonant, practical designs.

- 1 **Project Introduction** (10 hours)
 - 1.1 Introduction to building typologies
 - 1.2 Programmatic and functional requirements
 - 1.3 Overview of architectural and structural systems
 - 1.4 Focus on climate-responsive design
- 2 **Literature Review and Case Studies** (30 hours)
 - 2.1 Conduct literature review on climate-responsive design
 - 2.2 Review of relevant standards and guidelines
 - 2.3 Analyze case studies on space planning and design
 - 2.4 Extract design strategies for climate-adaptive solutions
- 3 **Site Analysis** (10 hours)
 - 3.1 Conduct site analysis: Physical, sociocultural, environmental
 - 3.2 Identify site-specific climate conditions and influences
 - 3.3 Prepare site analysis diagrams
- 4 **Conceptual Design** (10 hours)
 - 4.1 Develop climate-responsive design concepts
 - 4.2 Explore massing, form, spatial organization
 - 4.3 Focus on sustainability and energy efficiency
 - 4.4 Create schematic designs



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| 5 | Design Development | (65 hours) |
| 5.1 | Application of inferences from literature and case studies | |
| 5.2 | Refine design into detailed drawings | |
| 5.3 | Focus on floor plans, sections, elevations | |
| 5.4 | Integrate climate-responsive and sustainable strategies | |
| 5.5 | Develop physical model | |
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| 6 | Final Design Representation and Presentation | (12 hours) |
| 6.1 | Prepare and present final drawings and models | |
| 6.2 | Refine presentation with climate-responsive focus | |
| 6.3 | Submit final drawings and 3D model | |
|
 | | |
| 7 | Final Presentation and Defense | (7 hours) |
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| 8 | Time Problem | (6 hours) |

References

1. Balmer, J., Swisher, M. T. (2013). Diagramming the Big Idea. Routledge.
2. Ching, F. D. (2023). Architecture: Form, Space, and Order. Wiley.
3. Neufert, P. (2012). Architects' Data. Blackwell Publishing Ltd.
4. Unwin, S. (2003). Analyzing Architecture. Routledge.
5. White, E. T. (1975). Concept Sourcebook. Architectural Media Ltd.
6. White, E. T. (1983). Site Analysis. Architectural Media.
7. Hyde, R. (2000). Climate Response Design: A Study of Buildings in Moderate and Hot Humid Climates. Spon Press.



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DESIGN THEORY II

ENAR 254

Lecture : 3
Tutorial : 1
Practical : 0

Year : II
Part : II

Course Objectives:

The objective of this course is to introduce theoretical frameworks, explore the influence of theory on design, and equip students with tools for procedural and reflective design thinking. It focuses on the relationship between architectural theory and practice, incorporating key interdisciplinary and intradisciplinary concepts. Through this course, students will gain essential design thinking skills for critical assessment and reflective practice.

1 Theory in Architecture (6 hours)

- 1.1 Basics of theory (Elements and characteristics)
- 1.2 Theory and history
- 1.3 Theory and design
- 1.4 Theory and criticism
- 1.5 Theory and key architectural manifestos

2 Space, Place, and Atmosphere (7 hours)

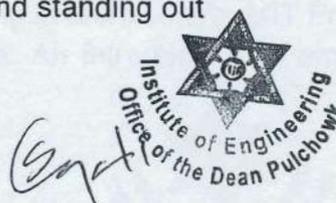
- 2.1 Space as a human dimension (Spatial needs)
- 2.2 Space, distance and time
- 2.3 Sense of place (Genius loci)
- 2.4 Atmosphere (Zumthor)
- 2.5 Hierarchies of spaces: Public and private space (Buildings)

3 Meaning, Language, and Symbolism in Architecture (8 hours)

- 3.1 Meaning: Symbolic and cultural context
- 3.2 Form language vs pattern language
- 3.3 Basics of symbolism (Signs and symbols)
- 3.4 Examples of iconography and metaphor
- 3.5 Case studies on meaning in architecture

4 Context in Architecture (8 hours)

- 4.1 Contextualization: Integration with surroundings
- 4.2 Decontextualization: Innovation and exploration
- 4.3 Recontextualization: Fitting and standing out



- 4.4 Cultural sensitivity in context
- 4.5 Environmental sensitivity in context

5 Responsibilities in Architecture (8 hours)

- 5.1 Ecological responsibility
- 5.2 Individual and community roles
- 5.3 Social engagement
- 5.4 Participatory design
- 5.5 Case studies on ethical practices

6 Procedural and Reflective Approaches (8 hours)

- 6.1 Design problem-solving techniques
- 6.2 Scenes and storytelling
- 6.3 Designer in action: Situations, mental spaces and frames
- 6.4 Decision parameter in design
- 6.5 Peer feedback and self-reflection

Tutorial (15 hours)

1. Self-site visit and spatial analysis: Assess how public and private spaces influence user interaction through spatial hierarchy and territoriality
2. Contextual review: Evaluate a building's fit with its context, focusing on contextualization, decontextualization and recontextualization, and present findings
3. Group discussion: Analyze architectural projects that demonstrate sustainability and community responsibility and submit a group report
4. Problem-solving workshop: Work in teams to apply design thinking to an architectural challenge and present solutions

Final Exam

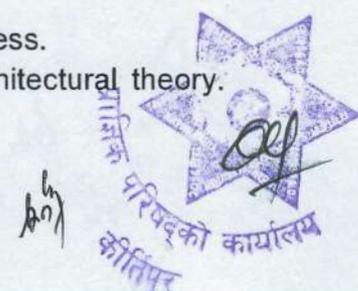
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

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

* There may be minor deviation in marks distribution.

References

1. Rowe, P. G. (1987). Design thinking in architecture. MIT Press.
2. Hale, J. A. (2000). Building ideas: An introduction to architectural theory. Wiley.



3. Mallgrave, H. F., Goodman, D. (2011). An introduction to architectural theory: 1968 to the present. Wiley-Blackwell.
4. Zumthor, P. (2001). Atmospheres: Environments, surrounding objects. Birkhäuser.
5. Lawson, B. (2001). The language of space. Routledge.
6. Krupinska, J. (2014). What an architecture student should know. Routledge.
7. Hertzberger, H. (1991). Lessons for students in architecture. 010 Publishers

Course Objectives:

The objective of this course is to introduce theoretical frameworks, explore the influence of theory on practice, and equip students with tools for procedural and reflective design thinking. It focuses on the relationship between architectural theory and practice, incorporating key interdisciplinary and trans-disciplinary concepts. Through this course, students will gain essential design thinking skills for critical assessment and creative problem-solving.

1. Theory in Architecture (6 hours)

- 1.1 Scope of theory (Functions and characteristics)
- 1.2 Theory and history
- 1.3 Theory and design
- 1.4 Theory and criticism
- 1.5 Theory and key architectural movements

2. Space, Place, and Atmosphere (7 hours)

- 2.1 Space as a human dimension (Spatial needs)
- 2.2 Scale, distance and time
- 2.3 Sense of place (Genius loci)
- 2.4 Atmosphere (Qualities)
- 2.5 The quality of space: Public and private space (Buildings)

3. Meaning, Language, and Symbolism in Architecture (8 hours)

- 3.1 Meaning: Symbolic and cultural context
- 3.2 Form language vs pattern language
- 3.3 Types of symbols (Signs and symbols)
- 3.4 Examples of iconography and metaphor
- 3.5 Exercises on meaning in architecture

4. Context in Architecture (5 hours)

- 4.1 Contextualization: Integration with surroundings
- 4.2 Environmentalization: Innovation and improvement
- 4.3 Recontextualization: Placing and handling



ELECTRIC MACHINE II

ENEE 253

Lecture : 3
Tutorial : 1
Practical : 3/2

Year : II
Part : II

Course Objectives:

The objective of this course is to provide knowledge on constructional details, operating principle, performance characteristics of 3-phase synchronous generators, 3-phase synchronous motors and single-phase AC motors. It also covers general understanding of the dq0 model of synchronous machines; and insights of reluctance motors, permanent magnet motors and special purpose motors.

- 1 **Three Phase Synchronous Machines** (3 hours)
 - 1.1 Basic concept of synchronous machines as generator and motor
 - 1.2 Comparison with dc generator and dc motor
 - 1.3 Constructional details: Armature core and windings, types of rotor, exciter
 - 1.4 Advantages of stationary armature over rotating armature in DC machine

- 2 **Three Phase Synchronous Generator** (16 hours)
 - 2.1 Working principle, necessity of constant speed operation, speed governor
 - 2.2 EMF equation, distribution factor, pitch factor
 - 2.3 Operation at no-load and Load conditions
 - 2.4 Armature reaction and its affects with resistive load, inductive load and capacitive load, phasor diagrams
 - 2.5 Concept of synchronous reactance and impedance
 - 2.6 Voltage regulation, synchronous impedance, ampere-turn and zero power factor method
 - 2.7 Parallel operation of two synchronous generators and load sharing with speed-droop characteristics
 - 2.8 Transient condition, Transient and sub transient reactance
 - 2.9 Synchronous generator connected to an infinite bus
 - 2.10 Limits of active and reactive power generation-capability curve
 - 2.11 Losses and efficiency

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3 Three Phase Synchronous Motor (10 hours)

- 3.1 Operating principle, synchronous speed operation and torque production
- 3.2 Starting methods
- 3.3 No-load and load operation: Power angle (δ), phasor diagram
- 3.4 Effect of excitation on power factor of motor, V and inverted V curves
- 3.5 Power-angle characteristic of cylindrical rotor machine
- 3.6 Power-angle characteristic of salient pole rotor machine, two reaction model
- 3.7 Hunting in synchronous motor
- 3.8 Losses and efficiency
- 3.9 Synchronous condenser

4 DQ model of synchronous machines (4 hours)

- 4.1 Circuit equations of synchronous machines
- 4.2 Concept of d-axis and q-axis in synchronous machine and need of dq0 model of synchronous machine
- 4.3 Park's transformation, abc-dq0
- 4.4 DQ0 model of salient pole synchronous machine: Transformed circuit equations
- 4.5 Power equation in dq0 model, power invariance in abc and dq0 reference frame

5 Single Phase AC Motor and Special Purpose Motors (12 hours)

- 5.1 Single phase induction motors, construction, operating principle and double revolving field theory
- 5.2 Self-starting split phase induction motors
 - 5.2.1 Capacitor start motor, its operating principle and characteristic curve
 - 5.2.2 Capacitor start and run motor, its operating principle and characteristic curve
 - 5.2.3 Shaded pole motor, its operating principle and characteristic curve
- 5.3 Single phase synchronous motors (Reluctance and hysteresis motors)
- 5.4 Switched reluctance motor: Construction, operating principle and torque speed characteristic
- 5.5 Permanent Magnet Synchronous Motor (PMSM): Principle of operation, construction (Surface-mounted PMSM, Interior-PMSM), EMF and torque equation, torque-speed characteristics, features and application of PMSMs
- 5.6 Brushless DC Motor: Constructional feature of brush less DC (BLDC) motors, Comparison of brushless DC motor relative to induction motor drives, principle of operation of brushless dc motor, classification of BLPM DC motor, EMF and torque equation, torque-speed characteristics, features and applications of BLDC motors

Bed



5.7 Special purpose motors: Universal, stepper and servo motors

Tutorial

(15 Hours)

1. Exercises on synchronous machine concepts, construction, and advantages of stationary armature over rotating armature.
2. Problems on Three-Phase Synchronous Generator
3. Problems on Three-Phase Synchronous Motor
4. Practice on DQ0 model, Park's transformation, equivalent circuits, and power equations in DQ0 frame.
5. Problems on single-phase induction motors, self-starting methods

Practical

(22.5 hours)

1. To study no-load characteristic of 3-phase synchronous generator
2. To study Load characteristic of 3-phase synchronous generator with resistive, inductive and capacitive loads.
3. To study effect of excitation on performance of three phase synchronous motor and to plot V-curve
4. To study the characteristics of single-phase split phase motor and capacitor start and run motor and compare their characteristics
5. Study of the T-S characteristics of PMSM

Final Exam

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

Chapter	Hour	Marks Distribution *
1	3	6
2	16	20
3	10	12
4	4	6
5	12	16
Total	45	60

* There may be minor deviation in marks distribution.

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HISTORY OF WESTERN ARCHITECTURE

ENAR 253

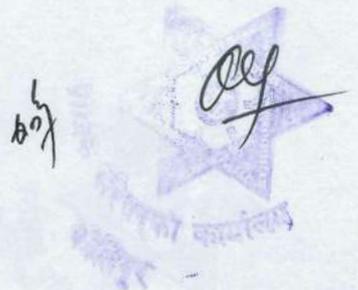
Lecture : 3
Tutorial : 0
Practical : 1

Year : II
Part : II

Course Objectives:

The objective of this course is to equip students with a comprehensive understanding of the evolution of architectural styles, techniques, and cultural influences in the Western world. This includes examining the development of Western architecture from prehistory to the Industrial Revolution, analyzing the cultural, religious, and technological factors that shaped architectural styles and construction techniques throughout history, and fostering critical thinking to compare historical architectural advancements and their influence on modern architecture.

- 1 **Prehistoric Architecture** (3 hours)
 - 1.1 Early shelter constructions and their characteristics
 - 1.2 An overview of prehistoric settlements
- 2 **Ancient Egyptian Architecture** (6 hours)
 - 2.1 Development of ancient Egyptian funerary and religious architecture
 - 2.2 Egyptian temple architecture's evolution and salient characteristics
 - 2.3 Key features of tombs and mortuary temples
- 3 **Ancient Greek Architecture** (8 hours)
 - 3.1 The development of Greek architecture in ancient minion and Mycenaean civilization
 - 3.2 Greek classical orders: Doric, ionic, and Corinthian
 - 3.3 The idea of Greek civic architecture and its evolution
- 4 **Ancient Roman Architecture** (8 hours)
 - 4.1 Innovation in materials and technological development in Roman architecture, and engineering
 - 4.2 Roman city planning and design characteristics
- 5 **Early Christian and Byzantine Architecture** (3 hours)
 - 5.1 The evolution of early Christian architectural design
 - 5.2 The development of Byzantine architecture



- 6 **Romanesque Architecture** (3 hours)
 6.1 Development of Romanesque architecture
 6.2 Essential elements of the Romanesque style
- 7 **Gothic Architecture** (4 hours)
 7.1 Origin and development of Gothic architecture
 7.2 Characteristics Gothic architecture
- 8 **Renaissance Architecture** (6 hours)
 8.1 The evolution of Renaissance architecture and the revival of classical ideas
 8.2 Examining the philosophies of distinguished academics, covering elements of Baroque and Renaissance architecture.
- 9 **Neoclassical Architecture and Industrial Revolution** (4 hours)
 9.1 Neoclassicism's salient characteristics
 9.2 Industrial Revolution and the shift to modernism

Practical (15 hours)

Students are required to prepare an analytical graphical report on various topics related to western architecture. The report should cover aspects such as historical context, social and cultural influences, religious significance, materials used, and construction techniques. Students should create posters based on their reports, present their findings, and participate in an exhibition within the department.

Final Exam

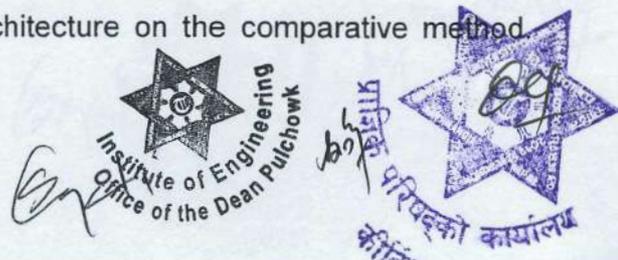
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

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

* There may be minor deviation in marks distribution.

References

1. Fletcher, B. (1967), A history of architecture on the comparative method London: Batsford.



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HYDRAULICS

ENCE 251

Lecture : 4
Tutorial : 2
Practical : 2/2

Year : II
Part : II

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)

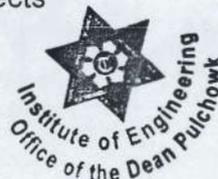
- 2.1 Minor head losses in pipes (Losses due to sudden enlargement, sudden contraction, entry, exit, obstruction, gradual contraction or enlargement, bends and fittings)
- 2.2 Hydraulic gradient line and total energy line
- 2.3 Pipes in series and parallel
- 2.4 Siphons (Working principle and applications)
- 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

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- 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

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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

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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	Mark 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

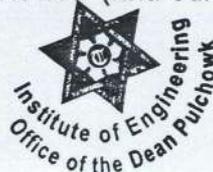
* There may be minor deviation in marks distribution.

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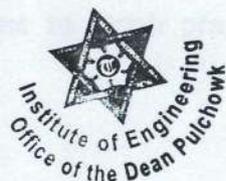
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MICROPROCESSORS AND MICROCONTROLLERS

ENEX 251

Lecture : 3
Tutorial : 1
Practical : 3

Year : II

Part : II

Course Objectives:

The objective of this course is to provide knowledge of microprocessors and microcontrollers to be able to develop assembly and C level programming and to develop a microprocessor/microcontroller-based system.

- 1 **Introduction** (5 hours)
 - 1.1 Introduction and history of microprocessor
 - 1.2 Microprocessor based system
 - 1.3 Bus organization of a microprocessor
 - 1.4 Stored program concept (SPC) and Von Neumann architecture, Harvard architecture
 - 1.5 Control Unit: definition, types, block diagram and comparison

- 2 **The 8085 Microprocessor** (10 hours)
 - 2.1 Features of 8085
 - 2.2 Pin description and internal architecture
 - 2.3 Instruction and data formats
 - 2.4 Addressing modes and instruction set
 - 2.5 Assembly programming examples
 - 2.5.1 Basic data transfer operations
 - 2.5.2 Basic arithmetic and logical operations
 - 2.5.3 Conditions and loops
 - 2.5.4 Array and table processing
 - 2.5.5 8-bit and 16-bit multiplication and division operations
 - 2.5.6 Data conversion: bcd to binary, binary to bcd
 - 2.6 Interrupts: interrupt pins, interrupt priorities, types of interrupts, interrupt instruction, processing sequence of interrupt

- 3 **The 8086 Microprocessor** (10 hours)
 - 3.1 Features of 8086
 - 3.2 Internal architecture and pipelining
 - 3.3 Addressing modes and instruction set



- 3.4 Assembly language syntax: comments, identifiers, reserve words, operators, statement, directives
- 3.5 Assembling, linking and execution
- 3.6 DOS function / keyboard & video services: int 10h, int 21h
- 3.7 Assembly programming examples
 - 3.7.1 Simple programming for data transfer, arithmetic and logical operations
 - 3.7.2 Conditions and loops
 - 3.7.3 Array and string processing
 - 3.7.4 8-bit and 16-bit multiplication and division operations
 - 3.7.5 Use if input and output devices
 - 3.7.6 Data conversion: bcd to binary, binary to bcd, etc
- 3.8 Interrupt: interrupt pins, priorities, instructions, types, ivt & its organization

4 Microprocessor System (10 hours)

- 4.1 Memory: classification, hierarchy
- 4.2 Address decoding and mapping i/o: definition, types
- 4.3 Address decoding for I/O ports (NAND Gate and Decoder) and memory (RAM, ROM) (NAND Gate and Decoder) for 8085
- 4.4 Interfacing: definition, needs, types, comparison
- 4.5 Serial Interface: synchronous & asynchronous transmission, RS 232
- 4.6 Parallel Interface: simple, strobe, single and double handshaking
- 4.7 PPI Device 8255: block diagram, modes of operations and control words generations
- 4.8 DMA and DMA controller
- 4.9 Bus timing diagram and rtl (register transfer language) for various instructions in 8085

5 The 8051 Microcontroller (10 hours)

- 5.1 Microcontroller survey: 4-bit, 8-bit, 16-bit and 32-bit microcontrollers
- 5.2 Introduction to 8051 microcontroller and its family
- 5.3 Pin description, internal architecture and programming model
- 5.4 Internal memory organization and SFR (Special Function Registers)
- 5.5 The timer control (TMOD) and special function registers
- 5.6 The timer mode control (TCON) and special function registers
- 5.7 Timer modes of operations (Mode 1, Mode2, Mode 3)
- 5.8 Addressing modes and instruction set
- 5.9 Programming examples in assembly and c
 - 5.9.1 Basic data transfer, arithmetic and logic operations
 - 5.9.2 Multiplication and division
 - 5.9.3 Conditions and loops
 - 5.9.4 Array processing and look up table
 - 5.9.5 Use of timers for delay and pulse generations
 - 5.9.6 Interfacing with seven segment display and liquid crystal display




Tutorial (15 hours)

1. Assembly programming examples in 8085 for different group of instructions
2. Assembly programming examples in 8086 for different group of instructions
3. Examples covering address decoding for input port, output port and memory
4. Assembly and C programming examples in 8051 for different group of instructions

Practical (45 hours)

1. Familiarization with data transfer instructions in 8085
2. Familiarization with arithmetic instructions in 8085
3. Familiarization with logical instructions in 8085
4. Familiarization with branching and stack operations in 8085
5. Familiarization with miscellaneous problems in 8085
6. Familiarization with assembly language programming in 8086
7. Familiarization with dos service int 21h in assembly language programming in 8086
8. Familiarization with bios service int 10h in assembly language programming in 8086
9. Solving miscellaneous problems with assembly language programming in 8086
10. Familiarization with data transfer, arithmetic and logical instruction in 8051
11. Familiarization with branching and bit manipulation operations in 8051
12. Familiarization with timers for delay and wave pulse generation in 8051

Final Exam

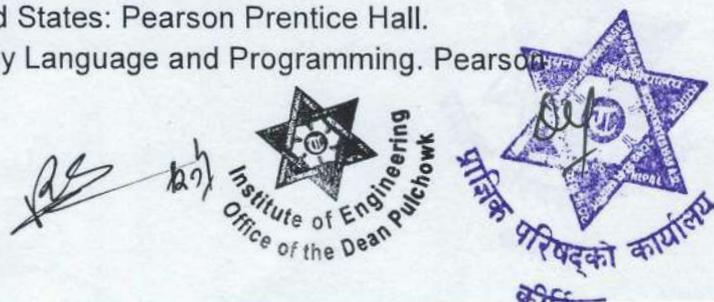
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hour	Marks Distribution *
1	5	4
2	10	12
3	10	12
4	10	12
5	10	12
2,3 and 5	-	8
Total	45	60

* There may be minor deviation in marks distribution.

References

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1. Introduction (6 hours)

1.1 Introduction and history of microprocessors

1.2 Microprocessor based system

1.3 The organization of a microprocessor

1.4 Bus and program memory (ROM) and data memory architecture

1.5 Data path and control logic

1.6 Instruction set

1.7 Instruction format

1.8 Instruction execution

1.9 Data path and control logic

1.10 Data path and control logic

1.11 Data path and control logic

1.12 Data path and control logic

1.13 Data path and control logic

1.14 Data path and control logic

1.15 Data path and control logic

1.16 Data path and control logic

1.17 Data path and control logic

1.18 Data path and control logic

1.19 Data path and control logic

1.20 Data path and control logic


 प्राज्ञिक परिषद्को कार्यालय
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POWER SYSTEM ANALYSIS II

ENEE 252

Lecture : 3
Tutorial : 1
Practical : 3/2

Year : II
Part : II

Course Objectives:

The objective of this course is to provide foundational knowledge of interconnected power systems, focusing on the mathematical modeling of electrical networks. It aims to equip students with the ability to analyze load flow, symmetrical and unsymmetrical faults, and perform stability analysis of power systems.

1 Interconnected Power System (4 hours)

- 1.1 Overview of interconnected power system
- 1.2 Types: Isolated Vs. interconnected, need and importance
- 1.3 Real power-frequency (P-f), Reactive power-voltage (Q-V) problem and basic control mechanisms
- 1.4 Grid: Local, regional, national and international grid

2 Mathematical Model of Electrical Network (4 hours)

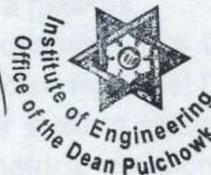
- 2.1 Basic concepts: Node equation and loop equation
- 2.2 Equivalent circuit of transformer and phase shift transformer
- 2.3 Admittance matrix: Formulation and modification
- 2.4 Applications of bus admittance matrixes in network analysis
- 2.5 Basic concept of bus impedance matrixes

3 Load Flow Analysis (9 hours)

- 3.1 Load flow problem, bus classification
- 3.2 Development of load flow equations
- 3.3 An approximate load flow solution
- 3.4 Iterative approaches for solving power flow equations
 - 3.4.1 Gauss-Seidal method
 - 3.4.2 Newton- Raphson method
 - 3.4.3 Fast decoupled load flow method
- 3.5 Power flow studies in system design and operation

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4 Symmetrical Fault Analysis (6 hours)

- 4.1 Definition and purpose of fault calculation
- 4.2 Types of faults in power system, symmetrical fault calculation
- 4.3 Short circuit computations of a synchronous machine (On no load and load)
- 4.4 Effect of short circuits

5 Symmetrical Components and Sequence Networks (6 hours)

- 5.1 Basic concepts
- 5.2 Symmetrical components transformation
- 5.3 Sequence components of the voltages, currents, impedance and power invariance
- 5.4 Phase shift in star-delta transformer
- 5.5 Sequence impedances and networks of transformers
- 5.6 Sequence impedances and networks of transmission lines
- 5.7 Sequence impedances and networks of synchronous machine

6 Unsymmetrical Faults Analysis (7 hours)

- 6.1 Symmetrical components analysis of unsymmetrical faults
- 6.2 Single line to ground fault
- 6.3 Line to line faults
- 6.4 Double line to ground faults
- 6.5 Open conductor faults
 - 6.5.1 Two conductors open
 - 6.5.2 One conductor open

7 Power System Stability (9 hours)

- 7.1 Concepts, classification
- 7.2 Dynamics of a synchronous machine
- 7.3 Swing equation
- 7.4 Power angle equation
- 7.5 Steady state stability, synchronizing power coefficients
- 7.6 Transient stability, equal area criterion
- 7.7 Numerical solution of swing equation
- 7.8 Stability enhancement techniques

Tutorial (15 hours)

- 1. Problems on node and loop equations, impedance matrix, admittance matrix formulation including transformer in a network
- 2. Problems on development of load flow equations, bus classification, and iterative methods (Gauss-Seidel, Newton-Raphson, Fast Decoupled)
- 3. Problems on symmetrical faults in power system network (no load and loaded synchronous machine) and symmetrical components of machine.

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transformer (with different configurations), transmission line, and impedance

4. Problems on unsymmetrical fault analysis
5. Problems on the swing equation, steady-state/transient stability, and equal area criterion

Practical

(22.5 hours)

1. Introduction to simulation of short, medium, and long transmission lines
2. Formation of Ybus matrix and Zbus matrix
3. Load flow analysis by Gauss-Seidel, Newton-Raphson, and fast decoupled method (any one method)
4. Symmetrical fault analysis
5. Unsymmetrical fault analysis (L-G fault only)

Final Exam

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

Chapter	Hour	Marks Distribution *
1 and 2	8	10
3	9	12
4	6	8
5	6	10
6	7	10
7	9	10
Total	45	60

* There may be minor deviation in marks distribution.

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RENEWABLE ENERGY AND CONVERSION DEVICES

ENAE 251

Lecture : 3
Tutorial : 1
Practical : 2

Year : II
Part : II

Course Objectives:

The objective of this course is to provide fundamental knowledge to detect potential renewable energy sources near to farm and development of skills on their conversion devices. After completion of this course, the students will be able to use locally available energy sources to fulfill the requirements of farm power devices using appropriate tools and methodology.

- 1 **Introduction** (4 hours)
 - 1.1 Energy sources and their classification
 - 1.2 Earth energy cycle and human interference
 - 1.3 Energy consumption by fuel type and economic sectors in Nepal
 - 1.4 Energy requirement in agricultural production system
 - 1.5 Concept of energy audit and tools of energy analysis

- 2 **Solar Energy** (18 hours)
 - 2.1 Availability and distribution of solar radiation
 - 2.1.1 Spatial and temporal distribution
 - 2.1.2 Measurement of solar radiation
 - 2.1.3 Solar angle, angle of incidence and solar time
 - 2.1.4 Incidence of solar radiation on horizontal and inclined surfaces
 - 2.1.5 Solar energy potential and distribution in Nepal
 - 2.2 Application of solar energy
 - 2.2.1 Solar electricity
 - 2.2.2 Solar thermal energy application
 - 2.3 Solar plate collectors
 - 2.3.1 Principle
 - 2.3.2 Types of solar plate collectors: Flat and concentrating
 - 2.3.3 Material of construction of solar plate collectors
 - 2.3.4 Design considerations of solar plate collectors
 - 2.4 Solar passive heating devices
 - 2.4.1 Types and use
 - 2.4.2 Thermal storage walls and attached green houses
 - 2.4.3 Thermal storage roof



- 2.5 Solar crop dryers
 - 2.5.1 Types of solar crop dryers
 - 2.5.2 Natural convection solar dryers
 - 2.5.3 Forced convection solar dryers
 - 2.5.4 Mixed mode solar dryers
 - 2.5.5 Design considerations
 - 2.5.6 Performance evaluation
- 2.6 Photovoltaic conversion
 - 2.6.1 Fundamentals of photovoltaic cell
 - 2.6.2 Materials, manufacturing process and performance
 - 2.6.3 Applications: Home/street lighting, water pumping, refrigeration and cold storage
 - 2.6.4 Design procedures for solar PV system
 - 2.6.5 Installation and maintenance

3 Bioenergy Technologies

(13 hours)

- 3.1 Biomass
 - 3.1.1 Definition and characteristics of biomass
 - 3.1.2 Application of bioenergy
 - 3.1.3 Collection and preconditioning of biomass
 - 3.1.4 Briquetting and pelleting
 - 3.1.5 Biomass conversion technologies
 - 3.1.6 Biomass potential and application in Nepal
- 3.2 Thermochemical conversion technologies
 - 3.2.1 Basic principles and process
 - 3.2.2 Types of thermochemical conversion technologies: pyrolysis, gasification, combustion, and hydrothermal liquefaction
 - 3.2.3 Design procedures for thermochemical conversion technologies
 - 3.2.4 Factors affecting thermochemical conversion
 - 3.2.5 Products and their application
- 3.3 Biochemical conversion technologies
 - 3.3.1 Basic principles and process
 - 3.3.2 Types of biochemical conversion technologies: Anaerobic digestion and fermentation
 - 3.3.3 Design procedures for biochemical conversion technologies
 - 3.3.4 Factors affecting biochemical conversion
 - 3.3.5 Products and their application
- 3.4 Chemical conversion technologies
 - 3.4.1 Basic principles and process
 - 3.4.2 Types of chemical conversion technologies: Hydrolysis and transesterification
 - 3.4.3 Design procedures for chemical conversion technologies
 - 3.4.4 Factors affecting chemical conversion
 - 3.4.5 Products and their application

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4 Wind Energy (5 hours)

- 4.1 Basic wind data- speed and direction
- 4.2 Diurnal and seasonal variation in wind speed and direction
- 4.3 Types of wind energy converters
- 4.4 Performance and efficiency of windmill
- 4.5 Wind energy potential and application in Nepal
- 4.6 Design procedures for wind power for farm

5 Micro and Small Hydroelectric Systems (5 hours)

- 5.1 Classification of water wheels and turbines
- 5.2 Components of water wheels and turbines
- 5.3 Design considerations of hydropower
- 5.4 Power output and efficiency
- 5.5 Installation and operation management
- 5.6 Hydropower potential and distribution in Nepal
- 5.7 Applications of hydropower in agricultural and rural development

Tutorial (15 hours)

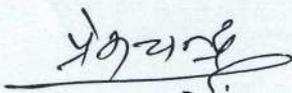
1. Energy audit of a campus building
2. Design of solar water heating system for a house
3. Design of solar crop dryer
4. Design of solar PV system for a house
5. Design of biogas plant for a house
6. Design of a wind pump for a farmland
7. Design of a micro-hydropower for a village

Assignments

Prepare a report on biogas plant/solar farm/micro/small hydropower plant.

Practical (30 hours)

1. Measurement of solar radiation using Pyranometer
2. Testing of solar thermal water heater
3. Efficiency testing of a flat plate solar collector
4. Performance analysis of a passive solar greenhouse
5. Efficiency evaluation of a solar cooker
6. Testing of a mixed model solar crop dryer
7. Proximate analysis of biomass
8. Operation and performance evaluation of a pyrolysis/gasification reactor
9. Fermentation of biomass to produce ethanol
10. Transesterification of vegetable oil to produce biodiesel





Final Exam

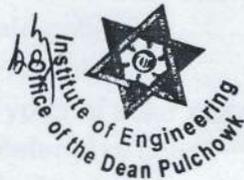
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1	4	4
2	18	24
3	13	20
4	5	6
5	5	6
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Jenkins, N., Ekanayake, J. (2024). Renewable energy engineering. Cambridge University Press.
2. Sukahtme, S. P. (2009). Solar Energy: Principle of Thermal Collection and Storage. Tata McGraw Hill Publishing Co., New Delhi (latest edition)
3. Garg, H. P., Prakash, J. (2017). Solar Energy Fundamentals and Applications. Tata McGraw Hill Publishing Co., New Delhi (latest edition)
4. Mittal, K. M. (1916). Biomass Systems: Principle and Applications. New Age International Pvt. Ltd., New Delhi
5. Harvey, A., Brown, A., Hettiararchi, P., Inversin, A. (1993). Micro hydro design manual: a guide to small-scale water power schemes. Rugby, UK: Practical Action Publishing.
6. S Kafle, M Gyawali, S Adhikari, JP Kropp, P Pradhan. (2024). Possibilities and challenges for converting waste biomass into fuel, feed, and fertilizer in Nepal. Regional Environmental Change, Springer, 24, 133.
7. Neupane, D., Kafle, S., Pradhan, P., Karki, K.R., Kim, D.H. (2022). Solar and wind energy potential assessment at provincial level in Nepal: Geospatial and economic analysis. Renewable Energy, Elsevier, 181, 278-291.
8. Hydropower potential in Nepal. <https://hydro.naxa.com.np/>



SOIL MECHANICS AND FOUNDATION ENGINEERING

ENCE 258

Lecture : 3
Tutorial : 1
Practical : 2

Year : II

Part : II

Course Objectives:

The objective of this course is to provide students with a thorough understanding of the fundamental properties, principles, and behavior of soil under various loading and environmental conditions. The course aims to equip students with the knowledge and skills to apply these principles to analyze and design different earth structures across diverse soil types.

1 Introduction (2 hours)

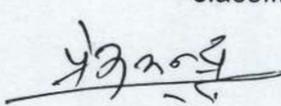
- 1.1 Definition of soil and rock
- 1.2 Importance of soil mechanics and soil problems
- 1.3 Historical development
- 1.4 Soil formation and soil types

2 Physical and Index Properties of Soils (6 hours)

- 2.1 Phase diagrams
- 2.2 Basic definition of phase relationship
- 2.3 Volume weight relationships
- 2.4 Water content determination
- 2.5 In-situ unit weight determination
- 2.6 Index properties of soil
- 2.7 Soil grained and soil aggregate properties of soil
- 2.8 Sieve analysis and sedimentation analysis
- 2.9 Relative density and Atterbergs limits

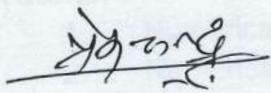
3 Soil Classification and Identification (3 hours)

- 3.1 Field identification of fine and coarse grained soil
- 3.2 Soil classification: Unified soil classification system, IS classification system, MIT, US bureau and international classification system, Textural classification system






- 4 **Soil-Water Integration** (4 hours)
- 4.1 Type of soil water
 - 4.2 Flow of water through soil mass: Darcy's law
 - 4.3 Permeability of soils
 - 4.4 Permeability of stratified soil deposits
 - 4.5 Determination of coefficient of permeability of soil by laboratory and field methods
- 5 **Soil Compaction** (3 hours)
- 5.1 Definition of compaction
 - 5.2 Factors affecting compaction
 - 5.3 Engineering significance of compaction
 - 5.4 Moisture-density relationship and degree of compaction
 - 5.5 Zero air void line
 - 5.6 Laboratory test
 - 5.7 Field compaction and compaction control
- 6 **Principle of Effective Stress** (5 hours)
- 6.1 Stress in subsoil
 - 6.2 Effective stress principle / physical meaning of effective stress
 - 6.3 Computation of effective stress for the static and flow conditions
 - 6.4 Capillarity in soils
 - 6.5 Quick sand condition and remedial measures
 - 6.6 Seepage pressure
 - 6.7 Two dimensional flow: Laplace's equation
 - 6.8 Flow nets and their application
- 7 **Shear Strength of Soils** (5 hours)
- 7.1 Concept of shear strength
 - 7.2 Principle planes and principle stresses
 - 7.3 Mohr's stress circle and failure envelope
 - 7.4 Mohr-coulomb theory of shear strength
 - 7.5 Relation between principle stresses at failure
 - 7.6 Critical void ratio
 - 7.7 Types of shear tests
 - 7.8 Measurement of shear strength in laboratory



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8 Consolidation and Settlement (4 hours)

- 8.1 Difference between compaction and consolidation
- 8.2 Tarzaghi's piston spring analogy for primary consolidation
- 8.3 Consolidation tests
- 8.4 Pressures-void relationship
- 8.5 Settlement calculation
- 8.6 Normally consolidated and over consolidated clay

9 Earth Pressure (5 hours)

- 9.1 Introduction to earth pressure
- 9.2 Types of earth pressure
- 9.3 Effect of wall movement on earth pressure
- 9.4 Earth pressure at rest
- 9.5 Rankine's earth pressure theory
- 9.6 Coulomb's earth pressure theory
- 9.7 Stability analysis on earth retaining structures

10 Foundation (3 hours)

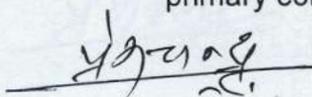
- 10.1 Site investigation for foundation
- 10.2 Definition, function and types of foundation
- 10.3 Location and depth of foundation
- 10.4 Factors affecting types of foundation
- 10.5 Concept of spread and mat foundation

11 Bearing Capacity and Settlement of Shallow Foundations (5 hours)

- 11.1 Basic definition and their relationship
- 11.2 Factors affecting bearing capacity
- 11.3 Types of shear failures
- 11.4 Tarzaghi's general bearing capacity theory
- 11.5 Effect of water table on bearing capacity
- 11.6 Ultimate bearing capacity in cohesive and cohesionless soils
- 11.7 Foundation settlement
- 11.8 In-situ test of bearing capacity

Tutorial (15 hours)

- 1. Numerical Problems on three phase diagrams of soils
- 2. Numerical Problems on soil water and permeability of soils.
- 3. Numerical Problems on soil compaction
- 4. Numerical Problems on effective stress
- 5. Numerical Problems on shear strength of soils
- 6. Numerical Problems on Press void relationship and settlement due to primary consolidation of soils





7. Numerical Problems on earth pressure and stability analysis of retaining structure
8. Numerical problems on bearing capacity of soils

Practical

(30 hours)

1. Water Content by oven drying and pycnometer methods
2. Specific gravity by pycnometer method
3. Field density by core cutter and sand replacement methods
4. Sieve analysis of coarse grained soil
5. Hydrometer analysis of fine grained soil
6. Liquid limit and plastic limit of fine grained soil
7. Coefficient of permeability by constant head and variable head permeameter methods
8. Standard Proctor compaction test
9. Unconfined compression test
10. Direct shear test

Final Exam

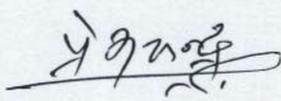
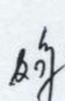
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Mark distribution*
1 and 2	8	16
3,4 and 5	10	16
6	5	8
7	5	8
8	4	8
9	5	8
10 and 11	8	16
Total	45	80

* There may be minor deviation in marks distribution.

References

1. Murthy, V.N.S. (2017). A Textbook of soil Mechanics and Foundation Engineering. UBS Publishers and Distributors.
2. Rao, G.R. (2016). Basic and Applied Soil Mechanics. New Age International.
3. Punmia, B.C. (2005). Soil Mechanics and Foundation Engineering. Laxmi Publications.
4. Arora, K.R. (2020). Soil Mechanics and Foundation Engineering. New Delhi: Standard Book House.

 
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SOIL MECHANICS ENCE 253

Lecture : 4
Tutorial : 2
Practical : 2

Year : II
Part : II

Course Objectives:

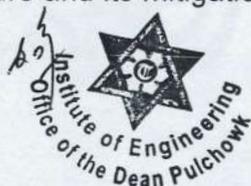
The main objective of this course is to introduce the fundamental concepts of soil, including its index and engineering properties. Additionally, the course aims to provide knowledge of the mechanical behavior of soil under both static and dynamic loading conditions. By the end of the course, students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

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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

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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

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Final Exam

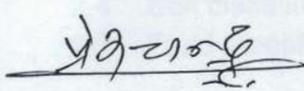
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	6	6
2	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.





STRENGTH OF MATERIALS AND THEORY OF STRUCTURES

ENCE 257

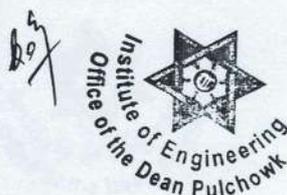
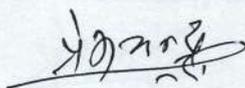
Lecture : 3
Tutorial : 2
Practical : 1

Year : II
Part : II

Course Objectives:

To provide fundamental knowledge, concept and methods of analysis for solving problems related to different load conditions, stress and strains on structures and components. The students will be able to analyze, calculate and design basic components of structure and other engineering components on the basis of strength, stiffness and stability of the material

- 1 **Introduction** (3 hours)
 - 1.1 Types of structure based on material used
 - 1.2 Statically determinate and indeterminate structures
- 2 **Stresses and Strains** (4 hours)
 - 2.1 Definition of stresses and strains
 - 2.2 Relationship between stresses and strains
 - 2.3 Elastic and elastoplastic behavior under various stress loads
- 3 **Types and Characteristics of Stresses** (3 hours)
 - 3.1 Tensile test of different material
 - 3.2 Ultimate stresses
 - 3.3 Allowable stresses and factor of safety
 - 3.4 Stress concentrations
 - 3.5 Elastic constants
- 4 **Stress and Strain Analysis** (4 hours)
 - 4.1 Hooke's law, modulus of elasticity, Poisson's ratio and modulus of rigidity
 - 4.2 Deformation of axially loaded bar, generalized Hooke's law
 - 4.3 Stresses due to change in temperature
- 5 **Theory of Flexure and Torsion** (5 hours)
 - 5.1 Coplanar and pure bending
 - 5.2 Radius of curvature, flexural stiffness



- 5.3 Elastic and plastic bending (15 hours)
 5.4 Beam deflection
- 6 Buckling (2 hours)**
- 6.1 Definition of buckling
 6.2 Euler's formula for column with different end restraints
 6.3 Concept of effective length and slenderness ratio
- 7 Deflection of Beam (6 hours)**
- 7.1 Double integration method
 7.2 Deflection by strain energy
 7.3 Curvature, slope and deflection
 7.4 Deflection by moment area method
 7.5 Deflection by conjugate beam method
- 8 Influence Lines for Simple Structures (8 hours)**
- 8.1 Concept of Influence line
 8.2 Influence line diagram for reaction at supports, bending moments and shear force
 8.3 Determination of reactions, bending moments and shear forces using influence line diagram
- 9 Statically Determinate Arches and Frames (4 hours)**
- 9.1 Types of arches and frames
 9.2 Three hinged arches with the support at the same level
 9.3 Determination of support reactions, shearing forces, axial forces, bending moments in arches and frames
- 10 Statically Indeterminate Structures (6 hours)**
- 10.1 Types of indeterminate structures, static and kinematic indeterminacy
 10.2 Slope deflection method
 10.3 Moment distribution method

Tutorial (30 hours)

1. Stress and Strain Analysis
2. Theory of Flexure and Torsion
3. Buckling of Column
4. Deflection of Beam
5. Statically Determinate Arches and Frames
6. Statically Indeterminate Structures

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Practical**(15 hours)**

1. Uniaxial tension test
2. Torsion test
3. Bending test
4. Column behavior
5. Deflection of beams
6. Measurement of reactions in three hinged arches under different loading arrangements
7. Influence lines for beams

Final Exam

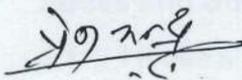
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1 and 2	7	5
3 and 4	7	7
5 and 6	7	12
7	6	8
8	8	6
9	4	6
10	6	16
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Gere, J. M., Timoshenko, S. P. (2002). Mechanics of Materials. United Kingdom: Stanley Thornes.
2. Wilbur, J. B., Norris, C. H. (2012). Elementary Structural Analysis. United States: Literary Licensing, LLC.
3. Popov, E.P. (2015). Mechanics of Materials (2nd Ed.). New Delhi: Prentice hall of India.
4. Wang, C.K. (1989). Intermediate Structural Analysis. McGraw Hill International.



STRUCTURE II

ENCE 260

Lecture : 3
Tutorial : 1
Practical : 0

Year : II
Part : II

Course Objectives:

The course aims to develop a conceptual understanding of structural principles in building design, fostering students' interest in structural systems as an integral part of architectural design. It provides knowledge on the behavior of modern structural materials, including timber, masonry, steel, and reinforced concrete. The course also aims to provide fundamental knowledge of timber, masonry, steel, and reinforced concrete structures, helping students understand and select appropriate structural systems for different architectural designs with basic concept of earthquake resistant design of buildings.

1 Timber Structures

(3 hours)

- 1.1 Types of timber and mechanical properties
- 1.2 Structural use of timber in the building: Timber floors, roofs, posts, columns
- 1.3 Joints and connections in the timber truss, beams and columns
- 1.4 Connections between different members in ancient structures
- 1.5 Design of simple timber floor, beams and columns

2 Masonry Structures

(8 hours)

- 2.1 Modes of failure: In-plane failure and out-of-plane failure
- 2.2 Slenderness ratio of masonry wall
- 2.3 Concept of wall density
- 2.4 Common deficiencies observed in masonry structures during past earthquakes
- 2.5 Importance of box action in masonry structures: Horizontal and vertical bands, bandages, splints and ties
- 2.6 Role of vertical reinforcement at corners/junctions and jambs

3 Steel Structures

(12 hours)

- 3.1 Structural steel: Mechanical properties and stress-strain curve of mild steel
- 3.2 Simple design of compression and tension (Ties) members
- 3.3 Introduction to simple steel beams
- 3.4 Riveted and welded connections: Codal requirements
- 3.5 Introduction to standard and built-up steel sections, functions and use
- 3.6 Introduction to steel trusses for large span covering and space trusses

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4 Reinforced Concrete (RC) Structures (12 hours)

- 4.1 Types of RC structures
- 4.2 Properties of concrete and reinforcing steels
- 4.3 Design philosophy RC structures
- 4.4 Limit state method (LSM) of design for RC sections for bending and shear
- 4.5 Concept of bond strength and development length
- 4.6 Serviceability limit states (SLS) of deflection and cracking
- 4.7 Design of RC beam, one-way slabs, two-way slabs and columns

5 Earthquake Resistant Design of Buildings (10 hours)

- 5.1 Nature of earthquake forces
- 5.2 Behavior of structures in past earthquakes
- 5.3 Earthquake effects on the structures and deficiencies in the buildings
- 5.4 Principles of earthquake resistant design
- 5.5 Effect of building configuration, regular shapes, load path regularity and effect of floor and roof systems
- 5.6 Regular building: Geometry, mass and stiffness regularities
- 5.7 Plan irregularity
- 5.8 Elevation irregularity
- 5.9 Soft storey and weak storey effects
- 5.10 Codal provisions on configurations of buildings and ductile detailing

Tutorial (15 hours)

1. Simple timber beams and columns
2. Design of compression and tension members of steel structure
3. Simple steel beams
4. Steel connections
5. Design of reinforced concrete beams
6. Design of reinforced concrete columns
7. Design of reinforced concrete one-way and two-way slabs

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	5
2	8	10
3	12	15
4	12	15
5	10	15
Total	45	60

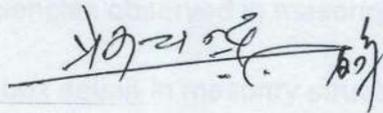
* There may be minor deviation in marks distribution.

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References

1. Duggal, S. K. (2013). Earthquake Resistant Design of Structures. India: OUP India.
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6. Duggal, S. K. (2007). Earthquake Resistant Design of Structures. India: Oxford University Press.
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14. NBC 105:2020, Seismic Design of Building in Nepal, Department of Urban Development and Building Construction, Government of Nepal.





SURVEY CAMP

ENCE 259

Duration: 10 days

Year: II

Part: II

Course Objectives:

The 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 Points for Large Area (2.5 days)

- 1.1 Reconnaissance, selection and marking of major traverse and link traverse (Approximately 1.5 km of perimeter, 13-15 control points for major traverse)
- 1.2 Measurement of two sets included angles and horizontal distances by EDM and bearings of traverse leg by prismatic compass
- 1.3 Computation of X and Y coordinates of major/minor control stations and elevation of the stations by auto level using correction by Bowditch method at closed circuit

2 Preparation of Topographical Map (3.5 days)

- 2.1 Selection of suitable site of approximately 3 to 5 hectares of Farm area/ semi built up area with some major and minor control points
- 2.2 Traversing for densification of control network; GPS and Total Station for detailing; Fly leveling by Auto level for elevation
- 2.3 Preliminary Works: Selection of suitable area of mapping
- 2.4 Establishment of additional control points with minimum five control points (except common stations) for link traverse inside/outside the major traverse; Perform three wire precise fly leveling for BM transfer; Computation of coordinates and elevation of the stations from the field observation; Data collection for topographical mapping; Plotting the data for the preparation of topographical map including contours at standard scale using computerized and manual method; Save all digital data in Data saving in data logger (Electronics field book)

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- 3 Weir Axis and Canal Head Work Site Survey (2 days)**
- 3.1 Selection of suitable weir axis and canal head work site area (Approximately 2000m x100m)
 - 3.2 Triangulation networks; Leveling by Auto level for Elevation; GPS and total station for detailing
 - 3.3 Preliminary Works: Selection of Suitable weir and headwork site and establish control points
 - 3.4 Data collection for topographical mapping; Perform leveling and for the plotting of L- section and X section; Computation of coordinates and elevation of the stations from the field observation; Plotting the data for the preparation of topographical map including contours

- 4 Canal Alignment/ Rural Road and Commanded Area Survey (2 days)**
- 4.1 Selection of length of suitable canal/ road alignment minimum of 500 m and command area of approximately 2 hectares
 - 4.2 Perform open Traverse; Leveling by Auto Level/ and Leveling Staff for Elevation; Total Station for detailing
 - 4.3 Preliminary works: selection of suitable site and establishment of control points
 - 4.4 Data collection for topographical mapping; Data collection for selection of grades and type of curve where necessary; Perform leveling and for the plotting of L- section and X section; Computation of coordinates and elevation of the stations from the field observation; Plotting the data for the preparation of topographical map including contours at standard scale; Draw L- section and X section of the center line of canal / road alignment; Detailing of command area and plotting using computerized method

Evaluation Criteria

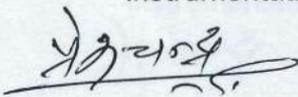
Internal Assessment

(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: Check and viva for computation and plotting of Major and Minor traverses/ Canal headwork (Weir axis) / Canal alignment/ Rural road/ Commanded area survey and traverse orientation

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

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

* There may be minor deviation in marks distribution.

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2. Preparation of Topographical Map (3.5 days)

- 2.1 Selection of suitable site of approximately 3 to 5 hectares of flat area with built up area with some major and minor control points.
- 2.2 Drawing for detailization of control network: GPS and Total Station for planimetry, LV leveling, by Auto level for elevation.
- 2.3 Preliminary Work: Selection of suitable site of mapping.
- 2.4 Establishment of appropriate control points with minimum five control points (three control points) for the traverse measurement. The ground traverse should be properly by leveling for BM transfer. Computation of coordinates and elevation of the stations from the field observation. Data collection for topographical mapping. Plotting the data for the preparation of topographical map including contours at standard scale using computerized and manual method. Save all digital data in Data logging in data logger (Picoviewer will book).

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)

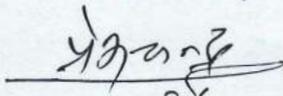
- 1.1 Reconnaissance, stations selection and pegging of major traverse: Closed traverse at least 1.5 km perimeter (15-20 stations) controlled with reference to national grid system
- 1.2 Measurement of major traverse angles and distances by Total Station/DGPS
- 1.3 Level transfer using Auto level/DGPS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

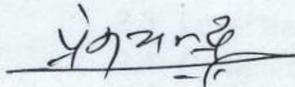
Final Exam

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	Mark distribution*	Remarks
Viva / Report Presentation	30	
Instrumentation	20	Should pass individually
Total	50	

* There may be minor deviation in marks distribution.



SURVEYING

ENCE 261

Lecture : 2
Tutorial : 0
Practical : 4

Year : II
Part : II

Course Objectives:

The objective of this course is to provide basic knowledge of land measurement and surveying techniques, and make the students to learn and understand the theory and field procedures by applying suitable surveying methods.

1 Introduction (2 hours)

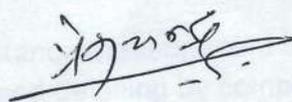
- 1.1 Historical background of surveying
- 1.2 Principle of surveying
- 1.3 Plane and geodetic surveying
- 1.4 Scales and types of scales

2 Linear Measurement and Offset (4 hours)

- 2.1 Units for distance and significant figures
- 2.2 Distance measurements technique and equipment
- 2.3 Accuracy, precision, error, sources of error, types of error
- 2.4 Distance measurements in fairly level and sloping ground
- 2.5 Principle of EDM and its application in distance measurements
- 2.6 Principle of chain survey and types of offsets

3 Compass Surveying (4 hours)

- 3.1 Introduction, definition of meridian, bearing and azimuth
- 3.2 Types of bearing, conversion from one system to another
- 3.3 Calculation of angles from bearings and vice versa
- 3.4 Local attraction
- 3.5 Compass traverse and plotting
- 3.6 Graphical adjustment of errors



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4 Leveling (7 hours)

- 4.1 Basic definition and importance of leveling
- 4.2 Principle and methods of leveling
- 4.3 Temporary and permanent adjustment of level, two peg test
- 4.4 Booking and calculation of reduced level
- 4.5 Classification of leveling: Fly leveling, profile leveling, cross sectioning and precise leveling
- 4.6 Adjustment of level circuits
- 4.7 Sources of errors in leveling

5 Contouring (3 hours)

- 5.1 Introduction, contour interval and horizontal equivalent
- 5.2 Factors affecting contour interval; Characteristics of contour interval
- 5.3 Methods of locating contours
- 5.4 Methods for interpolation of contours
- 5.5 Uses of contour maps
- 5.6 Computation of area: Trapezoidal and Simpson's 1/3 rules

6 Theodolite, Total station and Traversing (7 hours)

- 6.1 Basic definition of theodolite and total station
- 6.2 Construction principle and parts of theodolite and total station
- 6.3 Temporary adjustment of theodolite and total station
- 6.4 Measurements of horizontal angles, vertical angles and distances
- 6.5 Needs and significance of traversing
- 6.6 Field works for traversing and field notes
- 6.7 Computation of major traverse

7 Layout of Buildings (3 hours)

- 7.1 Setting out small buildings using chain and tape
- 7.2 Setting out large buildings using theodolite and tape
- 7.3 Setting out vertical control: Tall buildings from foundation to floor levels

Assignments

1. Tutorials provided in respective chapters
2. Exercise for map production in each chapter if applicable

Practical (60 hours)

1. Pacing, horizontal distance measurement in fairly level and sloping ground
2. Compass traversing and detailing by compass and offset methods
3. Two peg test
4. Fly leveling: Transfer reduced level from temporary bench mark (TBM) to TBM
5. Longitudinal leveling and cross sectional leveling

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6. Theodolite and total station handling and measuring the angle by directional method
7. Total station traversing and calculation of Gale's table
8. Minimum three room building setting out by linear and angular 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	2	2
2	4	4
3	4	4
4	7	8
5	3	3
6	7	6
7	3	3
Total	30	30

* There may be minor deviation in marks distribution.

References

1. Punmia B.C., Jain A.Kr., Jain A.K. (2005); SURVEYING VOL. I; VOL II & VOL III; Laxmi publication.
2. Basak N.N. (2004), Surveying and Levelling; Tata McGraw-Hill Education Pvt. Ltd.
3. Agor R. (1980); A Text Book of Surveying and Levelling; khanna publisher India
4. Duggal S. K.(2013); Surveying: Volume 1 & 2; Tata McGraw - Hill Education
5. Dhakal B. B.; Karki B. K. (2019); Engineering surveying I & II; Second edition; Heritage publication and distributors
6. Basnet N.; Basnet M. (2011); Basic Surveying I & II; National Book Center

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THEORY OF STRUCTURES II

ENCE 252

Lecture : 4
Tutorial : 2
Practical : 2/2

Year : II
Part : II

Course Objectives:

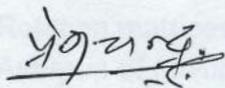
The course is designed to introduce key terminology and concepts related to displacements, stresses, strains, stiffness, and other parameters essential for understanding indeterminate systems. It provides practical examples to illustrate the fundamental concepts and theorems concerning static equilibrium, 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

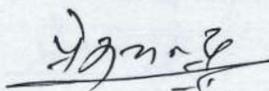
2 Theorem of Displacements (6 hours)

- 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

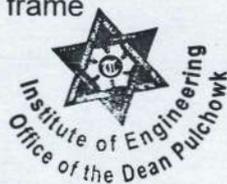
Practical (15 hours)

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

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- 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	Mark 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.

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TRACTOR SYSTEMS AND CONTROL

ENAE 252

Lecture : 3
Tutorial : 1
Practical : 2

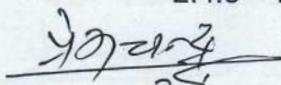
Year : II
Part : II

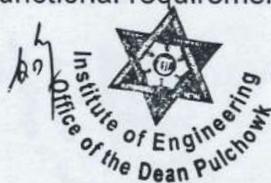
Course Objectives:

The main objective of this course is to introduce fundamental concepts, principles, and components of farm tractors and control systems, along with their applications. It also emphasizes the significance of ergonomic science, its principles, and their role in tractor design. Additionally, the course aims to equip students with the knowledge to analyze and optimize tractor applications for cost-effective field operations.

- 1 **Tractor as Source of Mechanical Farm Power** (2 hours)
 - 1.1 History of development of tractors
 - 1.2 Classification of tractors
 - 1.3 Essential features of farm tractors
 - 1.4 Ranges and availability in the country
 - 1.5 Tractor selection criteria

- 2 **Systems and Controls in Farm Tractors** (20 hours)
 - 2.1 Types of power transmission
 - 2.1.1 Two and four wheeled drive
 - 2.1.2 Hydrostatic and hydrodynamic drives
 - 2.1.3 Design principles for power transmission
 - 2.2 Clutch System
 - 2.2.1 Purpose and types
 - 2.2.2 Principle of operation
 - 2.2.3 Functional requirements
 - 2.2.4 Design parameters and procedure
 - 2.3 Gear Box
 - 2.3.1 Purpose and types
 - 2.3.2 Principle of operation
 - 2.3.3 Functional requirements
 - 2.3.4 Design parameters and procedure
 - 2.4 Differential and final drive
 - 2.4.1 Purpose and types
 - 2.4.2 Principle of operation
 - 2.4.3 Functional requirements





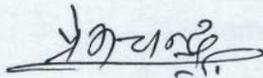
- 2.5 Steering System
 - 2.5.1 Purpose and types
 - 2.5.2 Principle of operation
 - 2.5.3 Components involved in mechanical steering
 - 2.5.4 Functional requirements
 - 2.5.5 Adjustments: Camber, caster, toe-in, toe-out, kingpin inclination, tie-rod locking
- 2.6 Brake System
 - 2.6.1 Purpose and types
 - 2.6.2 Principle of operation
 - 2.6.3 Functional requirements
 - 2.6.4 Design parameters and procedures
- 2.7 Hydraulic System
 - 2.7.1 Purpose and types
 - 2.7.2 Hydraulic circuit symbols
 - 2.7.3 Principle of operation
 - 2.7.4 Functional requirements
 - 2.7.5 Automatic position and draft controls
- 2.8 Auxiliary power transmission and power outlets
 - 2.8.1 Power takes off (PTO) system, its functions and types
 - 2.8.2 Belt, pulley and drawbar: Functional requirements and design parameters
 - 2.8.3 Special power drives for front and side mounted implements

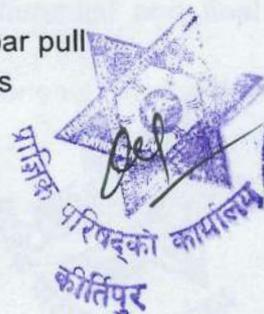
3 Traction and Traction Theory (4 hours)

- 3.1 Mechanics of a rigid wheel (Traction and towed)
- 3.2 Construction of tractor tyre
- 3.3 Inflation pressure
- 3.4 Theoretical soil thrust on traction device
- 3.5 Rolling resistance and travel reduction
- 3.6 Coefficient of traction and tractive efficiency
- 3.7 Tractive effort, rim pull, drawbar pull
- 3.8 Traction parameters and design of traction device
- 3.9 Traction aids and wheel ballasting: Types and selection criteria
- 3.10 Soil compaction in tillage and traction

4 Mechanics of Tractor Chassis (4 hours)

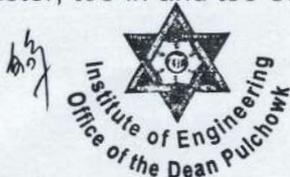
- 4.1 Static and dynamic forces acting on tractor chassis
- 4.2 Location of center of gravity and moment of inertia
- 4.3 Static equilibrium analysis
- 4.4 Analysis for maximum achievable drawbar pull
- 4.5 Longitudinal stability and stability at turns





- 5 Tractor Hitching (3 hours)**
- 5.1 Terminology used in tractor hitching
 - 5.2 Types: single axis hitching, two-axes hitching, automatic hitching
 - 5.3 Weight transfer and stability
 - 5.4 Break-away principle and other safety devices
- 6 Power Tiller and Mini Tiller (4 hours)**
- 6.1 Purpose and types
 - 6.2 Range and availability
 - 6.3 Control systems of power tillers
- 7 Ergonomic Principles in Tractor Design (3 hours)**
- 7.1 Human factors in tractor design
 - 7.2 Human tolerance to temperature, noise and vibration
 - 7.3 Importance of ergonomic principle in tractor seat design, Controls and Control Panel
- 8 Tractor Testing (3 hours)**
- 8.1 Purpose of testing
 - 8.2 Tractor test codes
 - 8.3 Engine and drawbar performance at full and part load
 - 8.4 Performance data of major makes and models of tractors used in Nepal
- 9 Economics of Tractor Use (2 hours)**
- Tutorial (15 hours)**
1. Clutch
 2. Gear Box
 3. Brake System
 4. Traction and Traction Theory
 5. Mechanics of Tractor Chassis
 6. Economics of Tractor
- Practical (30 hours)**
1. Disassembling and assembling of clutch system, components involved and maintenance operation
 2. Disassembling and assembling of gear box, components involved and maintenance operation
 3. Disassembling and assembling of differential and final drive, components involved and maintenance operation
 4. Study on steering system: Components involved and adjustments of camber, caster, toe-in and toe-out

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5. Disassembling and assembling of brake system, components involved and maintenance operation
6. Disassembling and assembling of hydraulic system, components involved and maintenance operation
7. Study on wheel parameters and ballasting in farm tractors
8. Hitching of mounted, semi-mounted and trailed type farm implements and stability analysis
9. Study on control systems of power tillers and mini tillers

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	22	32
3,4,5	11	12
6,7	7	8
8,9	5	8
Total	45	60

* There may be minor deviation in marks distribution.

Reference

1. Bureau of Indian Standards. (1998). Test codes for agricultural implements, I.C. engines, and tractors. New Delhi, India: Bureau of Indian Standards.
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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

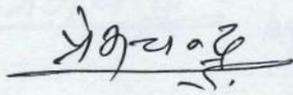
(2 hours)

- 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)





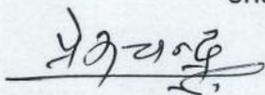
- 2.5 Selection of sources: Technical and legal considerations
- 2.6 Conservation of drinking water sources

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)

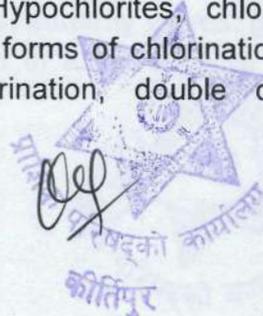
5 Intakes (3 hours)

- 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

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- 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 electro dialysis
 - 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 (CI, GI, 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)

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- 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

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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	Mark 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.

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