Pokhara University Faculty of Science and Technology	
Course Code: STR 214 (3 Credits)	Full Marks: 100
Course Title: Concrete Technology and Masonry Structure (3-2-2)	Pass Mark: 45
Nature of the Course: Theory and Practice	Total Lectures: 45 hours
Level: Bachelor/ Year: III/ Semester: V	Program: BE Civil/Civil and Rural

1. Course Description:

The purpose of this course is to provide the concept, knowledge and skill on concrete technology and masonry structural elements. The course focuses on various properties of concrete ingredients and will also be able to design concrete mix of different grades using different methods. This course explores the tools and techniques of quality control in different stages of construction by using concrete and masonry units. This course also helps to analyze and design of masonry structures for gravity and lateral loads using codal provisions.

2. General Objectives:

- Familiarize with ingredients of concrete and masonry materials
- Carry out mix design of concrete
- Test various properties of fresh and hardened concrete
- Conduct tests on masonry units and masonry structures
- Analyze and design simple masonry structure

3. Methods of Instructions:

Lecture, Tutorial, Discussion, Readings and Practical works

	4. Course Contents
	Part I: Concrete Technology
Specific Objectives:	**Unit 1: Introduction to Plain Cement Concrete and its Constituents (5 hours)**
Understand the properties of concrete constituents and familiarization with the various construction aspects of civil engineering.	1.1 Use of Concrete in Structure and Types of Concrete 1.2 Constituents of concrete material 1.2.1 Cement - Manufacturing of cement, Compound composition of Portland Cement and its role in Concrete, Hydration of cement 1.2.2 Sand and Aggregates – Types, Properties, Gradation and their effects in concrete strength 1.2.3 Water- Quality of water used in concrete, Effect of water-cement ratio on concrete performance (Abram's law) 1.2.4 Admixtures – Types and their Functions
	Unit 2: Mix Design of Concrete and Properties of Fresh Concrete (10 hours)

Understand the different tests of concrete (lab and site based) including its quality check, and to learn various mix design methods for producing durable, high-performance concrete.	2.1 Workability and its test (Slump Test, Compaction Factor Test, Flow Test and Vee-Be Test) 2.2 Manufacturing of Concrete and its Quality Control (Batching, Mixing, Transporting, placing (manual, lift and pumping), Finishing (Compaction) and Curing of Concrete 2.3 Segregation and Bleeding Effect 2.4 Concreting in Extreme Temperature 2.5 Mix Design 2.5.1 Nominal Mix Design 2.5.2 Probabilistic Concept in Mix Design Approach 2.5.3 Mix Design by DOE, ACI and IS Method
	Unit 3: Properties of Hardened Concrete (7 hours)
learn key factors affecting the strength of concrete.	3.1 Strength of Hardened Concrete and Factor Influencing Strength (Compressive Strength, Tensile Strength, Flexural Strength, Shear and Bond Strength) 3.2 Deformation of Hardened Concrete: Moduli of Elasticity, Poisson's Ratio 3.3 Shrinkage and Creep 3.4 Fatigue, Impact and Cyclic Loading 3.5 Thermal Properties 3.6 Effect of Porosity, and Gel-Space Ratio 3.7 Durability of Concrete and Factors Affecting It 3.8 Concrete Deterioration, Defects and their Preventive Measure
	Unit 4: Testing of Hardened Concrete and Quality Control (5 hours)
Evaluate the different methods of testing of concrete strength.	4.1 Compressive Strength Test, Direct Tensile Strength Test, Flexural Strength Test, Bond Strength 4.2 Non-Destructing Tests of Concrete 4.3 Variability of Concrete Strength and Acceptance Criteria as per Codal Provisions 4.4 Quality Control and Statistical Approach of Quality Assurance
	Unit 5: Special Types of Concrete (3 hours)
Identify different types of concrete.	5.1 Light Weight Concrete 5.2 Polymer Concrete 5.3 Porous Concrete 5.4 Plum Concrete 5.5 High Density/Roller compacted Concrete 5.6 Fiber Reinforced Concrete 5.7 Self-Compacting Concrete 5.8 High strength concrete

	5.9 Shotcrete
	Part II: Masonry Structures
	Unit 6: Constituents of Masonry Structures (2 hours)
Recognize masonry materials and masonry typology.	6.1 Types of Masonry Units: Bricks, Stones, Adobes, Concrete Blocks, ACC Block, CSE Block 6.2 Uses of Masonry Structures 6.3 Types of Brick Masonry Bond: - English Bond, Flemish Bond, Rat-Trap Bond 6.4 Types of Masonry Structures 6.3.1 Load Bearing and Non-Load Bearing Masonry 6.3.2 Reinforced and Unreinforced Masonry 6.5 Mortar 6.5.1Ingredients and properties of Wet Mortar 6.5.2 Strength of Mortar
	Unit 7: Design of Masonry Walls For Gravity Loads (8 hours)
Analyze and design of masonry wall for gravity loads.	7.1 Introduction to Codal Provisions (NBC109) and Guidelines (NBC202) 7.2 Analysis and Design Example for Gravity Loads for Solid wall, wall with Openings, Walls with Eccentric Loadings and Walls Acting as Columns 7.3 Design and Detailing of Reinforced Masonry Structures (Lintel Band)
	Unit 8: Masonry Structure under lateral loads (3 hours)
Discuss of masonry structure under lateral loads.	8.1 Traditional and Modern Methods: Use of Bond Stones, Types of Bands Used in Masonry Structures in order to Resist Lateral Load 8.2 Failure Behavior of Masonry Structures in Lateral Loads 8.3 Introduction of Composite Masonry 8.3.1 Infill Walls in Reinforced Concrete Frames 8.3.2 Uses of Bamboo in Masonry Structures
	Unit 9: Testing of Masonry Elements (2 hours)
Evaluate the different methods of testing of masonry walls.	9.1 Compressive Strength of Bricks and Walls 9.2 Diagonal Shear Test 9.3 Non-Destructive Tests – Schmidt hammer, Elastic Wave Tomography, Flat-Jack, Push Shear Test

5. List of Tutorials	
SN	
1.	Calculation of theoretical compressive strength w.r.t gel space ratio and rate of hydration, porosity.

2.	Design concrete mix by using different design methods, like DOE, IS and ACI
3.	Calculate standard deviation, mean target strength, Coefficient of Variance of given sample of concrete cube.
4.	Design and detailing of lintel beam in masonry structure.
5.	Design of different types of masonry wall under gravity loads.
6.	List out the different techniques used for resisting lateral load in masonry structure.

6. List of Practicals /Project works	
SN	Description
1.	Workability test for fresh concrete.
2.	Compressive strength test for hardened concrete by using destructive method.
3.	Indirect tensile test for hardened concrete by using destructive method.
4.	Compressive strength test of hardened concrete by using nondestructive test.
5.	Determination of strength of cement mortar.
6.	Determination of strength of masonry units.
7.	Demonstration of Non-destructive test in masonry wall.
8.	Tests in masonry wall.

5. Evaluation System and Students' Responsibilities

Evaluation System

The internal evaluation of a student may consist of assignments, attendance, term-exams, lab reports and projects etc. The tabular presentation of the internal evaluation is as follows:

Internal Evaluation	**Weight**	**Marks**	**External Evaluation**	**Marks**
Theory		**30**	**Semester End**	**50**
Attendance & Class Participation	10%			
Assignments	30%			
Internal Assessment	60%			
Practical		**20**		
Attendance & Class Participation	10%			
Lab Report/Project Report	20%			
Practical Exam/Project Work	40%			
Viva	30%			
Total Internal		**50**		
Full Marks: 50 + 50 = 100				

Students' Responsibilities

Each student must secure at least 45% marks separately in internal assessment and practical evaluation with 80% attendance in the class in order to appear in the Semester End Examination. Failing to get such score will be given NOT QUALIFIED (NQ) to appear the Semester-End

Examinations. Students are advised to attend all the classes, formal exam, test, etc. and complete all the assignments within the specified time period. Students are required to complete all the requirements defined for the completion of the course.

8. Prescribed Books and References

Text Books:

1. M. S. Shetty, Concrete Technology: Theory and Practice, S. Chand, New Delhi, 2005
2. A.S. Arya, Masonry and Timber Structures including earthquake resistant Design, Nem Chandra and Bros, Roorkee, 1987 5.

References:

1. P.K. Mehta, Paulo j. M. Monteiro, Concrete, Microstructure, Properties and Materials, University of California, Berkley (Indian Edition)
2. A.W. handry, B.P. Sinha, S.R. Davies, An Introduction to Load Bearing Brick Design, University of Edinburgh, 1981
3. P. Dayaratnam, Brick and Reinforced Brick Structures, Oxford and IBH Publishing Co. Pvt. Ltd. 1987)
4. A.M. Neville, J.J. Brook, Concrete Technology, International Students' Edition
5. IS 456, 2000- Plain and reinforced Concrete – Code of Practice
6. DUDBC.NBC 109, 1994 Masonry; Unreinforced
7. DUDBC. NBC 202- Load Bearing Masonry
8. IS 1905- 1987
9. IS: 383 – 1970
10. SP 20: 1991

Pokhara University Faculty of Science and Technology	
Course Code: CVL 322	Full Marks: 100
Course Title: Survey Field Project (0-0-2)	Pass Mark: 45
Nature of the Course: Field Based Practical	Total Hours:
Level: Bachelor	Program: BCE/BCRE

1. Course Description:

This course is designed to implement theoretical knowledge of surveying in the real field.

2. General Objectives:

The general objectives of this course are;

- To enable students independently carryout the civil engineering field survey
- To develop analytic skills of field survey data and drawing
- To enhance the skill for data and report presentation

3. Methods of Instructions:

Field based lectures, group discussions and field works.

4. Contents in Details	
Specific Objective	**Contents**
Develop the skills for establishment of traverse stations and collect the data for topographical map	1. **Topographical survey by using survey instruments** 1.1 Horizontal and vertical control for large area : Major traverse - Control of Easting and Northing coordinate by total station and elevation by Auto level (fly levelling) 1.2 Horizontal and vertical control inside the Major traverse: Minor Traversing -- Control of Easting and Northing coordinate by total station and elevation by Auto level (fly levelling) 1.3 Fly leveling for Establishing Temporary Bench Mark (BM) - two peg test 1.4 Computation, Plotting and Detailing - Computation For major and minor traverse for horizontal and vertical coordinate in proper format. - Reference sketch preparation of survey site

Conduct the road alignment survey and draw the formation level	**2. Road alignment survey** 2.1 Topographical map, longitudinal profile, cross section of road alignment. 2.2 Draw formation level.
Conduct the bridge site survey and draw the topographical map	**3.Bridge site survey** 3.1 Triangulation method 3.2 Reciprocal levelling 3.3 Draw the bridge site's topographical map, longitudinal section and cross section.
Conduct the photogrammetry and GNSS survey	**4.Topographical survey By using UAV and GNSS** 4.1 Topographical survey by UAV of same periphery and Taking sample detailing By RTK method of same location.

5. Evaluation System and Students' Responsibilities

Evaluation System

The internal evaluation of a student at the closed camp.

External Evaluation		**Marks**	**Internal Evaluation**	**Marks**
Presentation, Viva and Final Report Evaluation by External Evaluator: -Final Report(Drawing shall be prepared by using software) -Final Viva		20 10	Evaluation at the camp: - Field performance - Field Book and Field Drawings, Draft Report - Field Viva	35 20 15
Total Internal		**30**		**70**
Full Marks: 70+ 30 = 100				

Notes:

Unit1- The survey should cover minimum of 15 stations for major traverse, 3 minor stations, 1 km loop distance for fly leveling. (6 days)

Unit 2- Minimum 500 m chainage (1.5 days)

Unit 3- Coverage 150 m upstream and 50 m downstream (1.5 day)

Unit 4- UAV and GNSS survey (1 day)

The Number of students in each group should be 4 to 6.

Pokhara University
Faculty of Science and Technology

Course Code: CVL 350 (1 credit)
Course Title: Project 1(0-0-2)
Nature of the Course: Practical
Level: Bachelor

Full Marks: 100
Pass Marks: 45
Practical: 2 hrs/week
Program: BE Civil

1. Course Description

"Project I" offers students the chance to apply foundational civil engineering concepts to small-scale projects through theoretical approaches. Focusing on project planning, proposal development, and conceptual design, it sets the foundation for "Project II", where students can expand on their current project or start a new one.

2. General Objectives

The general objectives of this course are

- To enable the student to apply civil engineering concepts to enhance problem-solving and design skills.
- Develop project planning and proposal development skills, including theoretical reviews.
- Enhance teamwork and technical communication for effective project collaboration and presentation.

3. Contents in Detail

Specific Objectives	Contents
Investigate and refine a project topic to ensure alignment with course goals.	**Unit I: Project Topic Identification (6 hrs)** 1.1 Brainstorm potential topics. 1.2 Conduct preliminary literature review. 1.3 Assess and define project objectives 1.4 Present initial project proposals.
Develop a comprehensive project proposal by synthesizing key concepts and ideas.	**Unit II: Project Proposal Development (8 hrs)** 2.1 Analyze theoretical concepts related to the project. 2.2 Identify and define key variables. 2.3 Synthesize a conceptual framework. 2.4 Document and refine the project proposal
Design a preliminary framework that integrates theoretical concepts with practical design.	**Unit III: Initial Conceptual Design Development (5 hrs)** 3.1 Outline basic design ideas. 3.2 Create initial sketches and models. 3.3 Apply theoretical concepts to the design. 3.4 Present the preliminary design for peer review
Evaluate and refine design concepts based on feedback and theoretical analysis.	**Unit IV: Design Evaluation and Refinement (5 hrs)** 3.1 Review design concepts against objectives. 3.2 Identify areas for improvement. 3.3 Refine design based on feedback. 3.4 Validate design with theoretical analysis.
Report and present project findings effectively	**Unit V: Project Documentation & Reporting (6 hrs)**

Pokhara University
Faculty of Science and Technology

Course Code: CVL 350 (1 credit)
Course Title: Project 1(0-0-2)
Nature of the Course: Practical
Level: Bachelor

Full Marks: 100
Pass Marks: 45
Practical: 2 hrs/week
Program: BE Civil

1. Course Description

"Project I" offers students the chance to apply foundational civil engineering concepts to small-scale projects through theoretical approaches. Focusing on project planning, proposal development, and conceptual design, it sets the foundation for "Project II", where students can expand on their current project or start a new one.

2. General Objectives

The general objectives of this course are

- To enable the student to apply civil engineering concepts to enhance problem-solving and design skills.
- Develop project planning and proposal development skills, including theoretical reviews.
- Enhance teamwork and technical communication for effective project collaboration and presentation.

3. Contents in Detail

Specific Objectives	Contents
Investigate and refine a project topic to ensure alignment with course goals.	**Unit I: Project Topic Identification (6 hrs)** 1.1 Brainstorm potential topics. 1.2 Conduct preliminary literature review. 1.3 Assess and define project objectives 1.4 Present initial project proposals.
Develop a comprehensive project proposal by synthesizing key concepts and ideas.	**Unit II: Project Proposal Development (8 hrs)** 2.1 Analyze theoretical concepts related to the project. 2.2 Identify and define key variables. 2.3 Synthesize a conceptual framework. 2.4 Document and refine the project proposal
Design a preliminary framework that integrates theoretical concepts with practical design.	**Unit III: Initial Conceptual Design Development (5 hrs)** 3.1 Outline basic design ideas. 3.2 Create initial sketches and models. 3.3 Apply theoretical concepts to the design. 3.4 Present the preliminary design for peer review
Evaluate and refine design concepts based on feedback and theoretical analysis.	**Unit IV: Design Evaluation and Refinement (5 hrs)** 3.1 Review design concepts against objectives. 3.2 Identify areas for improvement. 3.3 Refine design based on feedback. 3.4 Validate design with theoretical analysis.
Report and present project findings effectively	**Unit V: Project Documentation & Reporting (6 hrs)**

	5.1 Document detailed project reports. 5.2 Create visual aids for presentation. 5.3 Practice presentation skills. 5.4 Present the final project
Total	**30 hrs.**

4. Method of Instruction

a. [Practical Sessions and Discussions] Weekly 2-hour sessions focused on theoretical project activities.
b. [Group Work] Collaborative development and design of project proposals.
c. [Progress Reviews] Regular feedback on project development.

5. Evaluation system and Students' Responsibilities

Evaluation

a. Continuous assessment through project milestones and faculty feedback
b. Final project report and presentation evaluating practical implementation and problem-solving abilities
c. Assessment based on the quality of planning, execution, and innovation in the project

Units	Types of Assignment	Weight	Marks	Type
Unit 1	Initial project proposal report	15%	8	Internal
Unit 2	Detailed project proposal report, presentation	20%	10	Internal
Unit 3	Design Outcome Presentation	25%	13	Internal
Unit 4	Design Report Preparation	25%	13	Internal
Unit 5	Draft Project Report, Presentation	15%	8	Internal
	Internal Evaluation	100%	50	
	External Evaluation	100%	50	

Students' Responsibility

Each student must secure at least 45% in internal evaluation with 80% attendance to be eligible for the project work marking. Failure to meet this will result in a "Not Qualified" (NQ) status, disqualifying them from the evaluation for project work. Students are expected to attend all classes and complete assignments on time. Missed exams, quizzes, or tests will not be rescheduled.

6. References

1. Oakes, W., & Leone, L. (2018). *Engineering your future: A brief introduction to engineering* (6th ed.). Oxford University Press.
2. Samuel, A., & Weir, J. (1999). *Introduction to engineering design* (1st ed.). Butterworth-Heinemann.
3. Beer, D. F. (2013). *A guide to writing as an engineer* (4th ed.). Wiley.
4. Kumar, R. (2023). *Research methodology: A step-by-step guide for beginners* (4th ed.). SAGE Publications.
5. Bhavikatti, S. S. (2010). *Basic civil engineering* [eBook]. New Age International Publishers.

Pokhara University
Faculty of Science and Technology

Course Code: STR 354 (3 Credits)
Course Title: Design of Steel and Timber Structure (3-2-0)
Nature of the course: Theory
Level: Bachelor

Full Marks: 100
Pass Marks: 45
Total Lectures: 45 hours
Program: BCE/BCRE

1. Course Description

This course is designed to provide a comprehensive knowledge of the design principles and practices related to analysis and design of various steel and timber structural elements in civil engineering.

2. General Objectives

The course is designed with the following general objectives:

- To enable the students to analyse and design the different steel structural elements and connections by using Limit state method.
- To develop the skills of students in designing timber structures, including solid, flitched/laminated, and box/built columns.

3. Contents in Detail

Specific Objectives	Contents
• Recognize different design methods; standards, codal provisions, and specifications.	**Unit I: Introduction (3 hrs)** 1.1 Difference between the structural steel and reinforcement bar 1.2 Advantages and disadvantages of steel structures 1.3 Methods of design of steel structure 1.3.1 Working Stress Method 1.3.2 Limit State Method 1.3.3 Ultimate Load Method 1.4 Standards, Codal Provisions, and specifications for Design of steel structures
• Recognize the fundamental concepts of analysing and designing of bolted and welded joints.	**Unit II: Analysis and Design of Joints (7 hrs)** 2.1 Analysis and design of Bolted Connections 2.1.1 Lap joint (Bolted and welded connections) 2.1.2 Butt joint (Bolted and welded connections) 2.2 Eccentrically loaded bolted and welded joints 2.2.1 Bracket lying on the plane of flange (Type I)

• Analyse and design the tension members.	**Unit III: Design of Tension Members (4 hrs)** 3.1 Introduction and various forms of tension member 3.2 Net section area and permissible stress 3.3 Design of tension members (Angle, Channel section) 3.3.1 Design strength due to gross section yielding 3.3.2 Design strength due to rupture of critical section 3.3.3 Design strength due to block shear failure 3.3.4 Design of End Connections 3.4 Design of lug angle
• Analyse and design the built-up compression members using both toe-to-toe and back-to-back configurations for lacing systems and batten systems for built-up members and design column splices.	**Unit IV: Design of Compression Members (7 hrs)** 4.1 Computation of different parameters for compression members 4.1.1 Determination of permissible stresses 4.1.2 Calculation of design compressive strength 4.2 Design of built-up members (Toe-Toe and Back to Back system) 4.2.1 Design of lacing system (single and double lacing) 4.2.2 Design of Batten system 4.3 Design of column splices
• Analyse and design the base plates for columns subjected to axial loads and eccentrically loaded columns.	**Unit V: Design of Column Bases (4 hrs)** 5.1 Design of base plate for axially loaded columns 5.2 Design of base plate for eccentrically loaded columns 5.3 Introduction to Anchor bolts and codal requirement 5.4 Design of Grillage base.
• Analyse and design the laterally supported, unsupported and built-up beams.	**Unit VI: Design of Steel beams (8 hrs)** 6.1 Introduction to flexure member 6.2 Web crippling effect and buckling of beams 6.3 Design of beam 6.3.1 Design of laterally stiffened (supported) and laterally unstiffened (unsupported) beams 6.3.2 Design of built-up beams 6.3.3 Design of End Connections 6.3.4 Curtailment and design of cover plates
• State the elements of plate girders, including the flange plate, web plate, and both longitudinal and transverse stiffeners.	**Unit VII: Plate Girder (3 hrs)** 7.1 Elements of plate girders in building and bridge (Flange,web plates) 7.2 Longitudinal and transverse stiffeners 7.3 Selection of optimum depth of plate girder 7.4 Design of Intermediate and end stiffeners

• Design different types of purlins (I-section, channel-section, and angle-section).	**Unit VIII: Design of Roof Trusses (5 hrs)** 8.1 Load calculation in roof trusses (Dead, Live, and wind loads) 8.2 Design of purlins 8.2.1 I-section purlin 8.2.2 Channel-section purlin 8.2.3 Angle-section purlin
• Analyse and design the solid, flitched beams and box/built up, spaced timber columns.	**Unit IX: Timber Structures (4 hrs)** 9.1 Introduction and codal provision 9.2 Design of flexure members 9.2.1 Solid beams 9.2.2 Flitched/Laminated beams 9.3 Design of column 9.3.1 Solid columns 9.3.2 Box/built column 9.3.3 Spaced column

4. Methods of Instruction

Lecture, Tutorial, Discussion, Readings

5. List of Tutorials

The following tutorial activities of 15 hours per group of maximum of 24 students are conducted to cover all the required contents of this course.

Units	Tutorials
2	Solving the problems related to the design of joints including bracketed connections.
3	Solving the problems related to the design of tension members.
4	Solving the problems related to the design of compression members including column splices
5	Solving the problems related to column bases
6	Solving the problems related to beams and built-up beams
7	Solving the problems related to plate girder
8	Solving the problems related to calculation of loads on roof truss and design of purlins
9	Solving the problems related to the design of timber beams and columns

6. Evaluation system and Students' Responsibilities

Evaluation System

In addition to the formal exam(s) conducted by the Office of the Controller of Examination of Pokhara University, the internal evaluation of a student may consist of class attendance, class participation, quizzes, assignments, presentations, written exams, etc. The tabular presentation of the evaluation system is as follows.

Internal Evaluation	Weight	Marks	External Evaluation	Marks
Theory		**50**	**Semester End**	**50**
Attendance and Class Participation	10%	5		
Assignments	30%	15		
Internal Assessment	60%	30		
Total Internal		**50**		
Full Marks: 50 + 50 = 100				

Students' Responsibilities

Each student must secure at least 45% marks in the internal evaluation with 80% attendance in the class to appear in the Semester End Examination. Failing to obtain such score will be given NOT QUALIFIED (NQ) and the student will not be eligible to appear in the End-Term examinations. Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during the period. If a student fails to attend a formal exam, quiz, test, etc. there won't be any provision for a re-exam.

7. Prescribed Books and References

Text Book

S K Duggal, *Limit state Design of Steel Structure*, McGraw Hill; 2nd Edition

References

1. IS 800:2007 General construction in steel code of practice, Bureau of Indian Standard
2. IS 808:1989 dimension for hot rolled in steel beam column, channel and angle section, Bureau of Indian Standard
3. IS 883:1994 design of structural timber in building- code of practice, Bureau of Indian Standard
4. K.S. Sairam, *Design of Steel Structures,* Pearson India Education; 2nd edition
5. S. Ramamrutham, *Design Steel and Structures,* Dhanpat Rai Publishing Company; 6th edition
6. S.S. Bhabikatti, *Design Steel and Structures*, I.K International Publishing House; 4th Edition
7. L.S. Negi, *Design of Steel and Timber Structures* McGraw Hill; 4th Edition
8. N. Subramanyam, *Design of Steel and Timber Structures*

Pokhara University
Faculty of Science and Technology

Course Code: WRE 352 (3 Credits)
Course Title: Irrigation and Drainage Engineering (3-2-0)
Nature of the course: Theory
Level: Bachelor

Full Marks: 100
Pass Marks: 45
Total Lectures: 45 hours
Program: BCE/BCRE

1. Course Description

This course describes the engineering techniques and mechanisms of planning, design, operation, maintenance and management of irrigation and drainage systems considering irrigation water requirements and water availability at diversion headworks.

2. General Objectives

The course is designed with the following general objectives:

- To provide knowledge about irrigation methods; canal systems and their operation and management
- To enable student to design canal irrigation system and associated structures (headworks, river training, regulating, cross-drainage)
- To make the students familiar with reclamation and drainage of irrigated field and design of surface and subsurface drainage structures

3. Contents in Detail

Specific Objectives	Contents
• Define irrigation methods with their suitability and able to plan the projects	**Unit I: Introduction (4 hrs)** 1.1 Need and advantages of irrigation and drainage 1.2 Disadvantages of over-irrigation and water-logging 1.3 Types and component of irrigation systems 1.4 Status, challenges and opportunities of irrigation development in Nepal 1.5 Crops, their seasons, cropping pattern and intensity 1.6 Commanded area and irrigation intensities 1.7 Methods of field irrigation and their suitability (canal, sprinkler, drip and sub-surface) 1.8 Planning of irrigation and drainage projects
• Estimate crop irrigation requirements, determine irrigation depth and frequency and design discharge for canals	**Unit II: Irrigation Water Requirements and Available Flows (6 hrs)** 2.1 Base period, kor period, duty, delta and their relation 2.2 Crop water requirements (Penman's method) 2.3 Operational water requirements 2.4 Seepage and evaporation losses in canals and fields 2.5 Effecive rainfall for irrigation 2.6 Irrigation efficiencies and irrigation requirements

	2.7 Soil-moisture-irrigation relation 2.8 Depth and frequency of irrigation 2.9 Design discharges for canals 2.10 Available flows at diversion headworks 2.11 Comparison of irrigation requirements and available flows at head works
• Design of lined and regime canal.	**Unit III: Canal Irrigation System and Design of Canals (8 hrs)** 3.1 Classification of canals 3.2 Components of a canal irrigation system 3.3 Alignment of canals 3.4 Canal cross-sections, standards and balancing canal depth 3.5 Sediment transport and tractive force approach of canal design 3.6 Design of non-alluvial stable canals 3.7 Silt theories (Kennedy and Lacey) and design of alluvial canals 3.8 Design of lined canals and economic of lining 3.9 Specific considerations for design of canals in hills
• Design and draw hydraulic structures of headworks	**Unit IV: Diversion Headworks and River Training (10 hrs)** 4.1 River stages and site selection of headworks 4.2 Components of weir/barrage (Detail drawing) 4.3 Seepage theory (Bligh, Lane and Khosla) 4.4 Design of weir and barrage with sloping glacies (crest, length and thickness of floor) 4.5 Design of under-sluice and head regulator (crest, length and thickness of floor); regulation of under-sluice and head regulator 4.6 Silt control at headworks by silt excluder, silt ejector and settling basin (design considerations) 4.7 Need and types of river training works 4.8 Design of guide bunds and launching apron 4.9 Spur types and design considerations
• Design regulating structures based on function and canal alignment	**Unit V: Canal Regulating Structures (6 hrs)** 5.1 Alignment of the off-taking channels 5.2 Function of head and cross regulators, outlet, drop and escapes 5.3 Deign of regulators and escapes (crest, length and thickness of impervious floor) 5.4 Types of outlet, design of pipe outlet (free and submerged) 5.5 Types of drop, design of Sharda type vertical drop (crest, length and thicknes of impervious floor)

• Select suitable cross drainage structure and design syphon aqueduct	**Unit VI: Cross Drainage Structures (5 hrs)** 6.1 Types of cross drainage structures and their suitability 6.2 Design consideration of cross drainage structures (detail drawing, drainage waterway, canal waterway, transitions, length and thickness of impervious floor and protection works)
• Explain water logging and determine drain discharge; design surface drains and spacing of tile drains	**Unit VII: Water Logging and Drainage (4 hrs)** 7.1 Causes, effects and preventive measures of water logging 7.2 Surface drainage systems and their design 7.2.1 Layout planning of surface drainage system 7.2.2 Internal drainage of bunded fields 7.2.3 Drain design (water level, maximum and minimum slope and cross-section) 7.3 Sub-surface drainage systems and their design 7.3.1 Layout of sub-surface drainage system 7.3.2 Flow of groundwater to drain and spacing of tile drains 7.3.3 Economical diameter of tile drain
• Describe mechanisms of operation, maintenance and management of irrigation systems	**Unit VIII: Mangement of Irrigation Systems (2 hrs)** 8.1 Operation and maintenance of irrigation systems 8.2 Canal operation and maintenance plans 8.3 Participatory irrigation management 8.4 Resource management plan 8.5 Irrigation management transfer

4. Methods of Instruction

The course primarily involves a series of lectures, local field visit, assignments and tutorials to be submitted on a regular basis that help the students to gain sufficient insight on planning, design and implementation of irrigation projects.

5. Tutorials (30 hours)

The following tutorial activities should be conducted to cover all the required contents of this course.

S.N.	Tutorials
1	Duty, Delta and period relation
2	Crop water and irrigation water requirements
3	Soil – moisture – irrigation relation and irrigation interval
4	Balancing depth for excavating canals
5	Design of stable canals
6	Desing of alluvial canals
7	Design of lined canals
8	Design of guide bund and launching apron
9	Design of hydraulic structures using Khosla's seepage theory
10	Design of sloping glacies weir bay
11	Design of cross and head regulators
12	Design of pipe outlet
13	Design of vertical drop

14	Design of siphon aqueduct
15	Design of surface and sub-surface drains

6. Practical Works /Field Trip

Field visit to an irrigation project (Headworks, Canals with structures, Distribution system), Group presentations and submission of individual field report with sketches and function of visited structures.

7. Evaluation system and Students' Responsibilities

Evaluation System

In addition to the formal exam(s) conducted by the Office of the Controller of Examination of Pokhara University, the internal evaluation of a student may consist of class attendance, class participation, quizzes, assignments, presentations, written exams, etc. The tabular presentation of the evaluation system is as follows.

Internal Evaluation	**Weight**	**Marks**	**External Evaluation**	**Marks**
Theory		**50**	**Semester End**	**50**
Attendance and Class Participation	10%	5		
Quizzes, Assignments	20%	10		
Field visit, Report Development and Presentation	20%	10		
Internal Assessment	50%	25		
Total Internal		**50**		
Full Marks: 50 + 50 = 100				

Students' Responsibilities:

Each student must secure at least 45% marks in the internal evaluation with 80% attendance in the class to appear in the Semester End Examination. Failing to obtain such score will be given NOT QUALIFIED (NQ) and the student will not be eligible to appear in the End-Term examinations. Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during the period. If a student fails to attend a formal exam, quiz, test, etc. there won't be any provision for a re-exam.

8. Prescribed Books and References

Text Books

1. Varshney, R.S., Gupta S.C. and Gupta R.L. Theory and Design of Irrigation Structures (Vol. I and II). Roorkee: Nem Chand and Brothers.
2. Garg, S.K. Irrigation Engineering and Hydraulic Structures. New Delhi: Khanna Publishers.
3. Arora, R. K. Irrigation Water Power and Water Resources Engineering. New Delhi: Standard Publication.Lial, M., Hungerford T. W. and John, H. (Year). *Mathematics with Applications*, Tenth Edition, Pearson

References

1. WECS (1998). Design Guidelines for Surface Irrigation in Terai and Hills of Nepal, (Vol. I and II).

Pokhara University
Faculty of Science and Technology

Course Code: ENV 352 (3 Credits)
Course Title: Sanitary Engineering (3-2-1)
Nature of the course: Theory & Practical
Level: Bachelor

Full Marks: 100
Pass Marks: 45
Total Lectures: 45 hours
Program: BCE/BCRE

1. Course Description

This course is designed to provide students with a comprehensive understanding of the technical and practical aspects to characterize and quantify the wastewater, and design, construction and maintenance of sanitary systems by covering topics such as quantity, quality of wastewater, design of conveyance system, treatment and end disposal process.

2. General Objectives

The course is designed with the following general objectives:

- To provide students with a comprehensive knowledge of the principles, design, construction, operation, and maintenance of sanitary systems.
- To equip students with the knowledge, skills to plan, organize, design, and implement safe, sustainable, and efficient sanitary systems for communities and industries.
- To enable students to analyze the latest technology, regulatory frameworks related to sanitation system while implementing in the field.

3. Contents in Detail

Specific Objectives	Contents
• State the composition and characteristics of wastes and quantification	**Unit I: Introduction (6 hrs)** 1.1 Definition: Sewer, sewerage, sewage / waste water, domestic sewage, industrial sewage, sanitary sewage, storm water, sullage, rubbish, garbage, refuse, solid waste 1.2 System of sanitation: Conversancy system, water carriage system 1.3 Systems of sewerage: Separate system, combined system and partially combined system 1.4 Quantity of waste water: Source of sanitary sewage, storm water, calculation of discharge of sanitary sewage, discharge of storm water by rational method and its limitation, factor affecting sanitary sewage, peak flow 1.5 Solid waste: characteristics and composition of solid waste, solid waste management practice 1.6 Review of regulations / guideline on wastewater and solid waste management
• Analyze chemical and physical characteristics of wastewater	**Unit II: Quality of Wastewater (5 hrs)** 2.1 Constituents and properties 2.2 Aerobic and anaerobic decomposition 2.3 Cycles of decomposition: nitrogen cycle, carbon cycle and sulfur cycle

	2.4 Biochemical oxygen demand (BOD), derivation of BOD, introduction to first and second stage BOD, ultimate BOD, relative stability, population equivalent 2.5 Sampling and analytical procedure: Units of measurements of parameters; Sampling of waste water; grab and composite samplers, preservatives and storage 2.6 Characteristics of wastewater: Physical analysis; color, odor, temperature and turbidity test; Chemical analysis; ammonical-nitrogen, DO, BOD, COD and chlorine test
• Analyze, design and construction of sewer and appurtenances	**Unit III: Design and Construction of Sewer (6 hrs)** 3.1 Hydraulic considerations: Manning's formula, Manning's roughness coefficient, Chezy's formula, Bazin's formula, Kutter's formula, Hazen William's formula 3.2 Self-cleaning velocity, minimum velocity and maximum velocity 3.3 Shapes of sewer: rectangular, horse shoe, circular and non-circular with their applications 3.4 Requirements of sewer materials, types of sewer materials: CI, concrete, PPR, PVC, DI, stainless steel, salt glazed stoneware 3.5 Derivation of hydraulic elements of circular sewer 3.6 Derivation of proportionate variables for partial flow in circular sewer 3.7 Stages of sewer construction 3.8 Sewer appurtenances: manhole, street inlets, catch basins, flushing devices, inverted siphon, ventilation shaft, sewer outlets
• Explain the environmental problems and methods of wastewater disposal,	**Unit IV: Disposal of Wastewater (4 hrs)** 4.1 Objectives of sewage disposal 4.2 Natural methods of sewage disposal: Dilution method – essential condition, self-purification process of streams, factor affecting self-purification of stream, oxygen sag curve and Streeter-Phelps equation; Land treatment method – essential conditions, broad irrigation, overland run-off, rapid filtration, sewage sickness and preventive measures
• Design the preliminary and primary treatment plants	**Unit V: Physical and Chemical Treatment of Wastewater (5 hrs)** 5.1 Objectives and importance 5.2 Wastewater treatment processes and layout of wastewater treatment plant 5.3 Preliminary and primary treatment of wastewater and their designs: screening, skimming tank / flotation tank, grit chamber, sedimentation tank, description of chemical precipitation and coagulation

• Analyze and design of secondary wastewater treatment.	**Unit VI: Biological Treatment of Wastewater (10 hrs)** 6.1 Objectives and importance 6.2 Sewage filtration: introduction of intermittent sand filter and contact beds, concepts, construction and design of trickling filter 6.3 Activated sludge process: concept, construction and design 6.4 Oxidation pond: concept, construction, design 6.5 Introduction of membrane technology, GAC treatment in waste water treatment
• Identify the sources of sludge and provide disposal solution.	**Unit VII: Treatment of Sludge and Disposal (5 hrs)** 7.1 Sources of sludge and necessity of sludge treatment 7.2 Aerobic and anaerobic digestion process 7.3 Methods of sludge treatment: thickening – concept of volume moisture content relationship; dewatering – types and process; digestion – types, design processes; other methods – drying and composting 7.4 Methods of sludge disposal: sludge drying bed, lagooning, land filling, incineration
• Illustrate different types of waste water disposal system in unsewered area.	**Unit VIII: Disposal of Wastewater in Unsewered Area (4 hrs)** 8.1 Brief description of pit privy, ventilated improved pit latrine (types and design), pour-flush latrine, compost latrine 8.2 Concept, construction, maintenance, working and design of septic tank 8.3 Disposal of septic tank effluent: design of soak pit, drain field and evapo-transpiration mound 8.4 Leaching cesspool

Note: The figures in the parentheses indicate the approximate periods for the respective units.

3. Methods of Instruction

Lecture, Tutorial, Discussion, Readings and Practical works

4. List of Tutorials

Chapters	Tutorials
1	Calculation of quantity of sanitary sewage and storm water
2	Calculation of BOD, relative stability and population equivalent
3	Numerical exercises on sewer design for full flow and partial flow conditions
4	Calculation of critical DO deficit and plotting of oxygen sag curve
5	Design of screening, skimming tank, grit chamber and sedimentation tank
6	Design of trickling filter, activated sludge process, oxidation pond (till dimension calculation)
7	Exercises on volume moisture content relationship, design of sludge digester
8	Design of VIP latrine, septic tank and soak pit
Field Visit: Field demonstration of the local wastewater treatment plant and submit the report.	

5. Practical Works

S.N.	Topic
1	Determination of turbidity of wastewater sample
2	Determination of pH of wastewater sample
3	Determination of total solids and dissolved solids of wastewater sample
4	Determination of chlorine in wastewater sample by Starch Iodide method
5	Determination of dissolved oxygen of wastewater sample from Winkler's Method and BOD test

6. Evaluation system and Students' Responsibilities

Evaluation System

In addition to the formal exam(s), the internal evaluation of a student may consist of quizzes, assignments, lab reports, projects, class participation, etc. The tabular presentation of the internal evaluation is as follows.

Internal Evaluation	Weight	Marks	External Evaluation	Marks
Theory		30	Semester-End examination	50
Attendance & Class Participation	10%			
Assignments	20%			
Presentations/Quizzes	10%			
Internal Assessment	60%			
Practical		20		
Attendance & Class Participation	10%			
Lab Report/Project Report	20%			
Practical Exam/Project Work	40%			
Viva	30%			
Total Internal		50		
Full Marks: 50 + 50 = 100				

Student's Responsibilities

Each student must secure at least 45% marks separately in internal assessment and practical evaluation with 80% attendance in the class in order to appear in the Semester End Examination. Failing to get such score will be given NOT QUALIFIED (NQ) to appear the Semester-End Examinations. Students are advised to attend all the classes, formal exam, test, etc. and complete all the assignments within the specified time period. Students are required to complete all the requirements defined for the completion of the course.

7. Prescribed Books and References

Text Book

1. Punmia, B.C., Jain, A.K. and Jain, A.K. *Environmental Engineering – II: Wastewater Engineering.* New Delhi, Laxmi Publications.

References

1. Modi, P.N. *Environmental Engineering, Volume II: Wastewater Treatment, Disposal and Air Pollution Engineering.* Delhi, Standard Book House.
2. Metcalf and Eddy, Inc. *Wastewater Engineering Treatment and Reuse.* McGraw Hill Education (India) Private Limited.

Pokhara University
Faculty of Science and Technology

Course Code: TRP 352 (3 Credits)
Course Title: Transportation Engineering II (3-1-1)
Nature of the course: Theory & Practical
Level: Bachelor

Full Marks: 100
Pass Marks: 45
Total Lectures: 45 hours
Program: BCE/BCRE

1. Course Description

The purpose of this course is to further strengthen the knowledge of highway engineering conducted in the previous semester. This course covers the design and analysis of traffic engineering, traffic control and management, and pavement engineering. In addition to this, it is intended to enhance the knowledge on the road construction methods with flexible and rigid pavements. Similarly, this course includes aspects of existing practices in highway maintenance in the Department of Roads (DoR).

2. General Objectives

The course is designed with the following general objectives:

- To comprehend the fundamental matters of the traffic engineering and design of intersections
- To enable the students to design the traffic control systems for safety and better traffic performance
- To enable the students to design the pavement as per the prevailing practices in Nepal.
- To equip the students with theoretical knowledge for the construction and maintenance of pavement.

3. Contents in Detail

Specific Objectives	Contents
• Comprehend the major aspects of traffic engineering	**Unit I: Introduction to Traffic Engineering (4 hrs)** 1.1 Definition and scope 1.2 Road user and vehicular characteristics 1.3 Perception reaction process, skid resistance and brake efficiency problems, acceleration problems
• Analyze the traffic data collected for the traffic performance and safety	**Unit II: Traffic Studies and Analysis (6 hrs)** 2.1 Traffic volume studies 2.2 Traffic speed and delay studies 2.3 Origin and destination study 2.4 Basic traffic flow parameters 2.5 Traffic capacity and level of service 2.6 Parking studies 2.7 Crash studies
• Design of traffic control systems including visualize the modern techniques of traffic management	**Unit III: Traffic Control and Management (8 hrs)** 3.1 Types of Intersections: priority junctions, channelized, rotary and roundabouts and grade separated 3.2 Intersection control and design principles 3.3 Traffic control devices: traffic sign, marking and Islands 3.4 Warrants and design of traffic signal

Specific Objectives	Contents
	3.5 Traffic calming measures 3.6 Design of street lighting 3.7 Intelligent Transportation System (ITS)
• Design and interpretation of pavement system (flexible and rigid)	**Unit IV: Pavement Engineering (11 hrs)** 4.1 Introduction, types and structural components of pavement 4.2 Factors controlling pavement design 4.3 Fundamentals of stress, strain and deflection on pavement structures (flexible and rigid) 4.4 Design of flexible pavement: latest edition of DoR guidelines 4.5 Design of rigid pavement: latest edition of DoR Guidelines 4.6 Pavement design for low volume roads (flexible and rigid types)
• Identify and recognize the methods of road construction techniques	**Unit V: Road Construction Technology and Specifications (10 hrs)** 5.1 Sequences of the road construction activities in various terrains 5.2 Road construction equipment and plants 5.3 Preparation of sub-grade (materials, methods, quality control) 5.4 Mass haul diagram 5.5 Construction of sub-base and base course (materials, methods, quality control) 5.6 Construction of bituminous wearing courses (materials, methods, quality control) 5.7 Construction of cement concrete pavement 5.8 Green road construction 5.9 Fundamentals of pavement recycling
• Identify the pavement conditions to justify the maintenance • Comprehend the prevailing practices in road maintenance	**Unit VI: Pavement Maintenance (6 hrs)** 6.1 Pavement evaluation practices (DoR) 6.2 Failures in flexible and rigid pavements 6.3 Types of road maintenance for bituminous and cement concrete pavement 6.4 Road maintenance planning and implementation practices in Nepal 6.5 Maintenance of low-cost roads (earthen, gravel and Water Bound Macadam (WBM) roads 6.6 Design and construction of overlay and its types (Indian Road Congress (IRC) and DoR methods) 6.7 Concept of performance-based maintenance 6.8 New technologies in the pavement Maintenance

4. Methods of Instruction

The lecture classes of the course are conducted for a group of 48 students. These lecture classes are mainly focused on the theoretical part for imparting the knowledge on the subject matter. The lecture classes are further strengthened by conducting tutorial classes for the 24 students in the group. The tutorials are mainly concentrated on solving engineering problems and preparing the design for the specific component of the subject. The ultimate product of the tutorials may be a complete design of roadway component. The practical classes are also

focused on conducting tests in laboratory and field observations. Laboratory or practical classes are mainly targeted to enhance students' skill for field based or laboratory-based activities.

5. List of Tutorials

The tutorials have been developed on the following theme of the course. These tutorials are designed as the component of a complete road design or solving a particular engineering problem.

S.N.	Tutorials	Teaching Hours
1	Traffic engineering survey/secondary data and analysis (Review of traffic study reports, DoR)	3
2	Collection of primary data (Volume, and Speed)	3
3	Review of pavement design reports (DoR)	3
4	Pavement design (application of DoR Guidelines for flexible and rigid)	6

6. Practical Works

S.N.	Practical	Teaching Hours
1	Field observation of Traffic signal operation and report preparation	3
2	DCP test and evaluation of sub-grade soil	3
3	Skid resistance test	3
4	Benkelman beam test and design of overlay	3
5	Case study: Field observation of road construction sites and report preparation	3

7. Evaluation System and Students' Responsibilities

Evaluation System

In addition to the formal exam(s) conducted by the Office of the Controller of Examination of Pokhara University, the internal evaluation of a student may consist of class attendance, class participation, quizzes, assignments, presentations, written exams, etc. The tabular presentation of the evaluation system is as follows.

Internal Evaluation	Weight	Marks	External Evaluation	Marks
Theory		30	Semester-End examination	50
Attendance & Class Participation	10%			
Field visit, Report Development and Presentation	20%			
Assignment/Presentations/Quizzes	20%			
Internal Assessment	50%			
Practical		20		
Attendance & Class Participation	10%			
Lab Report/Project Report	20%			
Practical Exam/Project Work	40%			
Viva	30%			
Total Internal		50		
Full Marks: 50 + 50 = 100				

Students' Responsibilities

Each student must secure at least 45% marks in the internal evaluation with 80% attendance in the class to appear in the Semester End Examination. Failing to obtain such a score will be given NOT QUALIFIED (NQ) and the student will not be eligible to appear in the End-Term examinations. Students are advised to attend all the classes and complete all the assignments within the specified period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during the period. If a student fails to attend a formal exam, quiz, test, etc. there won't be any provision for a re-exam.

8. References

1 Rodgers, M and Enright, B. (2019) Highway Engineering, 3rd Edition, Wiley Blackwell

2 Khisty, C. J. and Lall, B. K. (2017), Transportation Engineering - An Introduction, 3rd Edition, Pearson

3 Shrestha, D. K. and Marsani, A. (2020), Transportation Engineering II, 4th Ed, Heritage Publisher and Distributors, Kathmandu

4 Kadiyali, L. R. and Lal, N. B. Principles and Practices of Highway Engineering (Including Expressways and Airport Engineering), 7th Ed, Khhanna Publisher, New Delhi

5 Kadiyali, L. R. Transport Planning and Traffic Engineering, 10th Ed, Khhanna Publisher, New Delhi

6 Dr. S.K. Sharma (2019). Principles, Practice and Design of Highway Engineering. S. Chand and Company Limited, New Delhi

7 Dr. S.K. Khanna and Dr. C.E.G. Justo (2021). Highway Engineering. Nem Chand & Bros Roorkee (U.P.)

8 C.A. Flaherty (2002). Highway Engineering. Edward Arnold Publishers Ltd.

9 Khanna, S. K., Justo, C. and Veeraragavan A (2013). Highway Materials and Pavement Testing, Nem Chand & Bros Roorkee (U.P.), India.

10 Recent IRC pavement Design Guidelines (rigid and Flexible),

11 Recent DoR Pavement Design Guidelines (Flexible and Rigid)

12 Updated Standard Specifications for Road and Bridge Works, DoR Publication