BE (First Year) – First Semester

Semester I				Contact Hours			Marks		
							Theory		Pract
#	Code	Module	Credit	L	T	P	CA	EX	CA
1	MAT101	Engineering Mathematics-I	12	4	1	0	30	70	0
2	CPL101	Introduction to Programming	12	3	1	3	25	50	25
3	PHY101	Engineering Physics-I	12	4	0	2	25	50	25
4	CHE101	Engineering Chemistry	12	3	1	2	25	50	25
5	EGP101	Engineering Graphics	12	1	0	6	50	50	0
Total				**15**	**3**	**13**	**155**	**270**	**75**
			60	**31**			**500**		

Module Code & Title : MAT101 Engineering Mathematics-I
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mrs. Jyotih Lakshmi S and Ms. Tshering Denka
Module Coordinator : Mrs. Jyothi Lakshmi S

General Objectives:

To develop the student's abilities in mathematics, in particular the concept of Differential Calculus, Integral Calculus and Differential Equation that finds applications in various fields of Engineering.

Learning Outcomes:

On completion of the module, students will be able to:

1. Differentiate successive function by applying Leibnitz's theorem to find the nth derivative of the function. Apply appropriate Mean Value Theorems to expand the given function.
2. Identify the indeterminate form and evaluate the Limits.
3. Use Partial Differentiation to find the Jacobians of functions of two or more variables and expand the two variable functions by Taylor's series.
4. Choose the appropriate application of partial differentiation to find the Maxima and Minima of functions of two variables.
5. Employ Reduction formula to find the Integral and Definite Integral of functions.
6. Apply appropriate methods to test the Convergence and Divergence of different infinite series.
7. Solve Differential Equations of first order first degree and first order higher degree.
8. Find the Rank of a Matrix.
9. Solve Simultaneous Equation by Matrix method.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	4	60
Tutorial	1	15
Independent study/self-directed learning	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit II Term Test II: in 10th week, Unit V	1	20	30

1.2	Class Test: in 12th week, Unit III	1	5	
1.3	Assignment I: in 7th week, Unit II (Apply mean value theorem and its applications). Assessment criteria Presentation(0 .5 marks) Procedure (1.5 Marks) Final answer (0.5 Marks)	1	2.5	
1.4	Assignment II: in 13th week, Unit IV (Test the convergence and divergence of different infinite series). Assessment criteria Presentation(0 .5 marks) Procedure (1.5 Marks) Final answer (0.5 Marks)	1	2.5	
2	Semester End Examination: 3 hours, Closed book	1	70	70

Pre-requisite: None

Subject Matter:

Unit I: Differential Calculus

1.1. Successive differentiation.
1.2. Leibnitz's Theorem for the nth derivative of product of two functions.
1.3. Rolle's Theorem – Geometrical interpretation and its applications
1.4. Lagrange's Mean Value Theorem – Geometrical interpretation and its applications
1.5. Cauchy's mean value theorem – Geometrical interpretation and its applications
1.6. Expansion of a function
  1.6.1 Taylor's and Maclaurin's series in finite form with Lagrange's form of reminder and Cauchy's form of reminder
  1.6.2 Taylor's and Maclaurin's series in infinite form
1.7. Indeterminate form – $\left[\frac{0}{0}, \frac{\infty}{\infty}, 1^{\infty}, 0^{0}, \infty^{0}\right]$
1.8. Evaluation of limits – L' Hospital Rule
1.9. Partial Differentiation
  1.9.1 Functions of more than one independent variables.
  1.9.2 Limit and Continuity of functions
  1.9.3 Partial derivatives first and higher order
  1.9.4 Homogenous functions - Euler's theorem of Homogeneous functions
  1.9.5 Total Derivatives - Theorem of total differentials, Composite functions and theorem of composite function,
  1.9.6 Implicit functions (Typical cases),
  1.9.7 Errors and approximation
  1.9.8 Jacobians, properties of Jacobians, Functional relationship.
  1.9.9 Taylor's series functions of two variables.

1.10. Applications of Partial Differentiation - Maxima and Minima- Lagrange's method of undetermined multipliers, Differentiation under the Integral sign- Leibnitz Rule.

Unit II: Integral Calculus

3.1 Definite Integral as the limit of sum.
3.2 Reduction formula.
3.3 Application of Length, Area, Volume, Surface area of revolution.

Unit III: Infinite Series

3.1. Introduction, Definitions.
3.2. Convergence, Divergence, and Oscillation of a series.
3.3. General properties of a series:
  3.3.1. Series of positive terms.
  3.3.2. Comparison test, Integral test, Comparison of ratios.
  3.3.3. D'Alembert's ratio test.
  3.3.4. Raabe's test Logarithmic Test, Logarithmic Test, Cauchy's root test.
3.4. Alternating Series, Leibnits Rule, Series of positive or negative terms, Power series, Convergence of Exponential, Logarithmic and Binomial series.
3.5. Procedure for testing Series for convergence:
  3.5.1. Uniform convergence, Weirstrass's M-Test.
  3.5.2. Properties of uniform convergence of a series.

Unit IV: Differential Equations

4.1. Introduction, Definition, degree, Order and solution of a differential equation.
4.2. First order First Degree Equations:
  4.2.1. Variable separable.
  4.2.2. Homogeneous Equation
  4.2.3. Equation reducible to Homogeneous.
  4.2.4. Linear differential equation.
  4.2.5. Bernoulli's form, exact differential equation, Equation of first order and higher degree.

Unit V: Matrices and Determinants

5.1. Definition and elementary operations, Addition, subtraction and multiplication of matrices.
5.2. Determinants:
  5.2.1. Expansion of determinants.
  5.2.2. Properties of determinants by counter examples.
  5.2.3. Minors and co-factor of a determinant.
  5.2.4. Determinant of a square Matrix.
  5.2.5. Adjoin of a square matrix, Matrix inverse.
  5.2.6. Solution of simultaneous equation by Matrix method.
  5.2.7. Rank of a matrix, Elementary transformation of a matrix.

Reading Lists:

Essential reading:

1. Kreyszig, E. (2002). Advanced Engineering Mathematics (8 ed.). Singapore: John Wiley & Sons (Asia) Pvt Ltd.
2. Grewal, B.S. (2001). Higher Engineering Mathematics (36 ed). New Delhi: Khanna Publishers.
3. Dass, H.K. (2005). Advanced Engineering Mathematics (14 ed.). New Delhi: S.Chand& Company Ltd.
4. Jain, R. K., & Iyengar, R.K. (2003). Advanced Engineering Mathematics (2 ed.). New Delhi: Narosa Publishing house.
5. Prasad, I. B. (1982). Practical Mathematics Vol I and Vol II (6 ed.). New Delhi: Khanna Publishers.

Additional Reading:

1. Rao, S. B., & Anuradha, H. R. (1996). Differential Equations with Application and Programmes (1 ed.). Hyderabad: Universities Press (India) Ltd.
2. Vasishtha, A. R. (2002). Matrices (32 ed.). Meerut: Krishna Prakashan Media (P) Ltd.
3. Bali N.P &cDr. Manish Goyal (2014) A Text Book of Engineering Mathematics (9 ed). New Delhi : Laxmi Publications(P) Ltd.

4. Babu Ram, (2010), Engineering Mathematics (1 ed). New Delhi : Pearson

Date: Febraury4, 2017

Module Code & Title : CPL101 Introduction to Programming

Programme **:** BE in Information Technology

Credit **:** 12

Module Tutor **:** Mr. Yeshi Jamtsho, Mr. Karma Wangchuk and Mr. Manoj Chhetri

Module Coordinator : Mr. Manoj Chhetri

General Objective:

This module will familiarise students with programming concepts and the fundamentals of programming language to enable them to formulate and design solutions for basic mathematical problems.

Learning Outcomes:

On completion of the module, students will be able to:

1. Identify computer logical and hardware units.
2. Perform number system conversion.
3. Analyse and formulate the solution to solve given problem
4. Translate Algorithm, flowchart and pseudo-code to a program.
5. Write programs to implement array and function.
6. Write programs to implement structure and pointers.
7. Correct errors in the program codes.
8. Solve basic science and engineering problems
9. Use software tools available for programming.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Practical	3	45
Independent study/self-directed learning	1	15
Total		120

Assessment Approach:

Sl. No.	*Mode of Assessment*	*Nos.*	*Marks Allocated*	*Marks (%)*
1	**Continuous Assessment (Theory)**			
1.1	**Term Test**: Closed book, one hour duration in 5th and 10th week of the semester. Term 1(Unit I-III) & Term II (Unit IV-VI)	2	20	**25**
1.2	**Assignments**: To encourage student centred learning and to determine the students ability in solving the problems using the concepts covered in the class. Unit I-III(Assignment 01) after term I & Unit IV-VIII (Assignment 02) in the 12th week. Both the assignments assessment evaluation will be through: - Presentation – 3 marks - Content – 2 marks	2	5	
2	**Continuous Assessment (Practical)**			
2.1	**Practical Test**: 2 hours, closed book in 13th week.	1	10	**25**
2.2	**Lab Report**: Students must submit a report for every laboratory classes based on the format given by the tutors, every after practical class. **Assessment criteria (report)** • Flowchart. • Psuedocode.		5 1	

	• Correctness. • Indentation. • Readability and format.		1 1 1 1	
2.3	**Laboratory Assessment**: Students will be assessed based on their performance in every the laboratory class, every practical class. **Assessment criteria (Laboratory Assessment)** • Correctness /result. • Approach used.		10 3 7	
3	**Semester End Examination:** 3 hours, closed book.	1	50	**50**

Pre-requisite: None

Subject Matter:

Unit I: Introduction
1.1 Define software, hardware, system software, application software, program,
1.2 Machine language, assembly and high level languages, assembler, compiler, interpreter, editor, operating system.
1.3 Storage units: bits, bytes, kilo, mega, Giga bytes.
1.4 Number system: Decimal, binary, hexadecimal, octal conversions.

Unit II: Solution Formulation
2.1 Defining the problem; structuring the solution using the top down approach.
2.2 Algorithm: Definition, characteristics, examples.
2.3 Flowchart :concept of selection(if, nested if, if else, if else if) and iteration(entry controlled and exit controlled loop)
2.4 Pseudo-code: selection (if,nested if,if else,if else if) and iteration(entry controlled and exit controlled loop)

Unit III: Representation of Data and Basic Data Types
3.1 Integer, characters, Endian, IEEE 754 floating point representation,
3.2 ASCII, Unicode port representation.

Unit IV: Basic constructs
4.1 Constants, variables, Identifiers, Keywords, Header files, basic data types, operators, different types of operators, operands Expressions, Statements, Macros
4.2 The basic format of C program; input and output Selection statements(if ,nested if, if else, if else if, switch)
4.3 Iteration statements(for, while and do while loop)

Unit V: Functions
5.1 Concept of a function; programming a function; passing data to and from a function.
5.2 Predefined function, user defined functions scope,
5.3 Call by value and call by reference, visibility and lifetime of variables and functions,
5.4 Recursive function, C reference.

Unit VI: Arrays

6.1 Concept of an array; writing and reading to 1-D array, 2-D array and multi-dimensional arrays; passing arrays to and from functions.
6.2 Strings: Concept of string ,string related library functions

Unit VII: Pointers
7.1 **C**oncept of a pointer; simple applications of a pointer.
7.2 Array and pointer,
7.3 Function and pointer, Pointer to a pointer, Null pointer,
7.4 Dynamic memory allocation: Malloc and calloc

Unit VIII: Structures

8.1 Concept of a structure; simple applications of structures.
8.2 Array and structure ,pointer and structure,
8.3 Self-referential structure

Unit IX: Files
9.1 Opening & Closing a file – Writing to and Reading from a file –
9.2 Processing files – Library functions related to file – fseek(), ftell(), ungetc(), fread(), fwrite()

List of Practicals:
1. Demonstration of PC Hardware parts
2. Use of various IDE Compilers to write, compile and execute.
3. Write a Program to implement sequence statement.
4. Write a Program to implement selection statement.
5. Write a Program to implement iteration statement.
6. Write a function driven program
7. Write a program to implement 1-D & 2-D array.
8. Write a program to implement pointer
9. Write a program to implement function call by value and call by reference.
10. Write a program using structure
11. Write a Program to read and write files.

Reading Lists:

Essential Reading

1. Balagurusamy, E. (2011). *Programming in ANSI C* (4 ed.). New Delhi: Tata McGraw Hill Education Private Limited.
2. Kernighan, B. W. & Richite, D. M. (1998). *The C programming language* (2 ed.). Delhi: PHI Learning Private Limited.
3. Kanetkar, Y.P. (1991). *Let us C* (5 ed.). New Delhi: BPB publications.

Additional Reading

1. Xavier, C. (2008). *Introduction to computers and basic programming* (3 ed.). New Delhi: New Age International (P) Limited.
2. Ravichandran, D. (1996). *Programming in C* (1 ed.). New Delhi: New Age international Publishers.
3. Bronson, G. J. (2006). *A first book of ANSI C (Introduction to Programming)* (4 Ed.). Canada: Course Technology.

Date: June 16, 2017.

Module Code and Title **:** PHY101 Engineering Physics – I
Programme : BE in Civil Engineering
Credit **:** 12
Module Tutor **:** Mr. Rajesh Subedi and Mr. KelzangDorji
Module Coordinator **:** Mr. Rajesh Subedi

General objective:

This module will provide students with a fundamental understanding of physics required to understand its application in engineering. This module will also facilitate student learning by helping them develop problem solving skills related to the field of engineering .

Learning outcomes:

On completion of the module, learners will be able to:
1. Convert units from one system to other system
2. Apply vectors in plane and polar co-ordinates
3. Calculate the position, velocity and acceleration (graphically and numerically) in 2D and 3D
4. Calculate the forces related to position, velocity and acceleration using Newton's law.

5. Analyze the formation of waves on stretched string
6. Explain the nature of light and describe interference, diffraction and polarization
7. Analyze the results of observed practical experiments
8. Analyze the relationship between graphs and equations and how they represent physical situation.
9. Analyze the motion under gravity in relation to the value of 'g'.
10. Explain and relate motion of projectile with escape velocity.

Learning and teaching approach:

Approach	Hours per Week	Total Credit Hours
Lecture	4	60
Practical	2	30
Independent study/self-directed learning	2	30
Total		120

Assessment approach:

Sl. No.	***Mode of Assessment***	***Nos.***	***Marks Allocated***	***Marks (%)***
1	**Continuous Assessment (Theory)**			
1.1	Term Test: closed book, one hour duration in 5th and 10th week.	2	20	**25**
1.2	Assignment I: in 4th week, Unit I-III (Kinematics and Dynamics). Timely submission: no deduction of marks. Late submission: deduct **0.5** marks per day. Correctness in interpreting and drawing sketches: **0.5** Correctness in analysis of the problem: **1.25** Applying correct procedure and relevant equations and laws: **0.5** Correctness in answer: **0.25** Assignment II: in 8th week, Unit VI-VIII (Waves and Optics). Timely submission: no deduction of marks. Late submission: deduct **0.5** marks per day. Correctness in interpreting and drawing sketches: **0.5** Correctness in analysis of the problem: **1.25** Applying correct procedure and relevant equations and laws: **0.5** Correctness in answer: **0 .25** Will be awarded zero in case of Plagiarism.	2	5	
2	**Practical**			
2.1	Lab Record/Regular Laboratory assessment (weekly assessment).		10	**25**

	1. Aim of experiment – **0.25** 2. Apparatus required – **0.5** 3. Formulas and explanation - **1** 4. Theory (Description of experiment) - **1** 5. Procedure – **1.5** 6. Diagram – **2** 7. Observation tables and calculation – **2.5** 8. Result – **0.5** 9. Precautions – **0.25** 10. Cleanness and detail of the lab record- **0.5** The above beak ups are to be evaluated for each experiment and find average at the end for the total number of the experiments completed.			
2.2	Practical Exam: Closed book, 2 hour duration in 14th week.	1	10	
2.3	Viva-Voce: Closed book during the practical exam.	1	5	
3	**Semester Examination:** 3 hrs duration, closed book.	1	**50**	**50**

Students must obtain 40% each in the Continuous assessment of theory, practical and the semester end examination. The overall pass mark for the module is 50%.

Pre-requisites: None.

Subject matter:

Unit I: Revision of Mathematical tools applied to Physical problem

1.1. Units and their conversion.
1.2. Measuring Least Count using Vernier Calliper, Screw Gauge and Travelling Microscope and Spherometer.
1.3. Vector operations in Cartesian and plane polar co-ordinates with physical examples.
1.4. Function plotting with physical examples; No derivation of the equations to be done.
1.5. Analysis of force-2D and 3D by vector method
1.6. Moment by vector method

Unit II: Kinematics

2.1 Need of frames of reference in describing motion
2.2 One Dimensional motion
2.3 Two dimensional motion
2.4 Velocity and acceleration in polar coordinates.
2.5 Relative velocity
2.6 Motion with uniform velocity and uniform acceleration
2.7 Motion with varying velocity and varying acceleration
2.8 Motion under gravity
2.9 Projectile

Unit III: Dynamics

3.1 Introduction to Survey of common forces in nature
3.2 Newton's laws of motion; The need of First law in defining inertial frames;
3.3 Variable mass problems
3.4 Central forces; Inverse square force
3.5 Oscillations; General potential with stable equilibrium point, Solution of Differential equation with emphasis on initial conditions, Damped and forced oscillation.

Unit IV: Waves

4.1 Longitudinal and transverse waves
4.2 Waves on a stretched string,
4.3 Differential equation of wave
4.4 Superposition principle of waves,
4.5 Plane monochromatic waves, $v=n\lambda$
4.6 Plane, spherical and cylindrical wavefronts.

Unit V: Optics:

5.1 Introduction to nature of light
5.2 Interference of light; Coherent sources
5.3 Young's double slit
5.4 Thin films
5.5 Michelson's interferometer
5.6 Diffraction
  5.6.1 Fraunhofer single slit diffraction resolving power
  5.6.2 Two slit plane diffraction grating
5.7 Spectrum resolution
5.8 Polarization of light

List of Practical:

1. Measurement using screw gauge, slide/ Vernier calipers
2. Measurement of diameter of a capillary tube using travelling microscope
3. Study of oscillatory systems of a mass spring oscillator to determine 'g'.
4. Study of stationary waves to find the frequency of vibration using tuning fork
5. Use of prism spectrometer to find the angle of minimum deviation
6. Study of polarization of light using Laurent's half shade polarimeter
7. Measurement of wavelength of light using Interference of light from (a) Sodium source and (b) Helium-Neon source by 1. Newton' ring and 2. Air wedge methods
8. Study of diffraction of light using sodium and mercury source to find the wavelengths of primary colours of light
9. Finding the radius of curvature of the curved surfaces using Spherometer.

Reading List:

Essential Reading

1. Verma, H.C. (2009). *Concepts of Physics Part-I*. Bharati Bhawan (P&D) : India
2. Halliday, D., Resnic, R.& Walker, J. (2014). *Fundamentals of Physics* (10th edition). John Wiley & Sons Inc.: US

Additional Reading

1. Gaur, R.K. & Gupta, S.L. (2001). *Engineering Physics* (8th edition). Dhanpat Rai Publication (P) Ltd.: New Delhi
2. Kleppner, D&Kow, R.J.K. (1986).*An introduction to Mechanics* (4th reprint 2002) McGraw Hill Book Int.
3. Vasudeva A.S (2004), Modern Engineering Physics (4th edition). S Chand and company Ltd-New Delhi

Date: July 6, 2017

Module Code and Title : CHE101 Engineering Chemistry
Programme : BE in Civil Engineering
Credit : 12
Module Tutors : Mr. Basant Pradhan and Mr. Bharat K Humagai
Module Coordinator : Mr. Basant Pradhan

General Objectives:

The module aims to provide students with an understanding of the basic concepts, theories and principles of chemistry as a base to building and testing theories and the application of engineering chemistry. The module also intends to equip students with the basic chemical concepts to enable them to solve problems and make personal decisions involving chemical products. Further, it intends to develop students' ability to make observations, carry out measurements in the laboratory and draw conclusions based on those observations or measurements.

Learning Outcomes

On completion of the module, students will be able to:

1. Explain the concept of atoms.
2. Describe the principle of thermodynamics.
3. Compare addition polymerization reactions with condensation polymerization.
4. Suggest the right metal/alloys for the right purpose.
5. Illustrate the working of the electronic devices using the concept of nanochemistry and its applications.
6. Interpret the concept of rusting and its control.
7. Calculate the calorific value of the fuels.
8. Demonstrate scientific skills to carry out experiments in the laboratory.

Learning and Teaching Approach:

Approach	**Hours per Week**	**Total Credit Hours**
Lecture	3	45
Practical	2	30
Tutorial	1	15
Independent study/self-directed learning	2	30
Total		120

Assessment Approach:

Sl. No.	***Mode of Assessment***	***Nos.***	***Marks Allocated***	***Marks (%)***
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-II Term Test II: in 10th week, Unit III-V	2	20	**25**
1.2	**Assignment I**: in 2nd week, Unit V (Suggest the metals and alloys). **Assignment II**: in 5th week, Unit VIII (Interprete corrosion and its theories). **Marking Criteria for Assessment of Assignment** • Introduction – 0.5 • Content - 2 • Diagram/Chemical equation/ Scientific data – 1 • Conclusion – 1 Reference – 0.5	2	5	
2	Continuous Assessment (Practical)			
2.1	Regular Assessments: Assessment criteria (Lab Report)	1	10	25

	• Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).		1 2.5 2.5 3 1	
2.2	Practical Examination: 2 hours, closed book.	1	10	
2.3	Viva-Voce:	1	5	
3	Semester End Examination: 3 hours, closed book.	1	50	50

Prerequisite: None

Subject Matter:

Unit I: Atoms

1.1 de Broglie's formula
1.2 uncertainty principle
1.3 Wave mechanics,
1.4 Schrodinger equation
1.5 Particles in one dimension, degeneracy
1.6 Radial probability distribution functions.

Unit II: Molecules

2.1 LCAO method of diatomic
2.2 Hybridization (sp3d, sp3d2, sp3d3) and molecular orbital theory.

Unit III: Physical Chemistry

3.1 Energetic of chemical reaction and effect of temperature.
3.2 Application of thermodynamic principles to chemical reactions.
3.3 Feasibility and prediction of chemical reactions.
3.4 Thermodynamic calculation of equilibrium constants.
3.5 Gibbs Helmholtz equation.

Unit IV: Polymer Chemistry

4.1 Introduction
4.2 Classification of polymers and polymerization.
4.3 Addition and condensation polymerization
4.4 Chain growth and chain transfer polymerization.
4.5 Free radical, cationic and anionic polymerization and their mechanism.
4.6 Coordination polymerization and copolymers.
4.7 Tacticity of polymers.
4.8 Synthesis, properties and application of: polyethylene, polyvinyl chloride (PVC), polystyrene, phenol formaldehyde, epoxy resins, acrylonitrile butadiene styrene.
4.9 Compounds of plastic and Rubber (natural rubber and synthetic rubber).

4.10 Synthesis, properties and application of: Styrene-butadiene rubber, Neoprene, butyl rubber, silicon rubber.

Unit V: Metals and Alloys

5.1 Introduction,
5.2 Physical properties of metals, cast iron, wrought iron, steel, heat treatment of steel.
5.3 Definition of alloys, purpose of making alloys, classification of alloys, alloys of steel and its application, non-ferrous alloys and its industrial application.

Unit VI: Fuels and Combustion

6.1 Classification of fuels
6.2 Calorific value-LVC, HVC
6.3 Measurement of calorific value using bomb calorimeter (Numerical problems).
6.4 Knocking and anti-knocking for petrol and diesel (Octane number and cetane number).
6.5 Petroleum, refining of petroleum by fractional distillation.
6.6 Diesel index. LPG, natural gas, CNG-composition and application.
6.7 Biodiesel and Biogas-composition and application.

Unit VII: Nano chemistry

7.1 Introduction
7.2 Properties (electrical, mechanical and vibrational)
7.3 Carbon nano tubes – applications in fuel cells,
7.4 Catalysis and use of gold nanoparticles in medicine.

Unit VIII: Corrosion an its Control

8.1 Corrosion
8.2 Consequences of corrosion
8.3 Types of corrosion (galvanic corrosion, concentration cell corrosion, pitting
8.4 corrosion, crevice corrosion, stress corrosion, erosion corrosion, selective leaching)
8.5 Theories of corrosion (chemical/dry corrosion, electrochemical corrosion)
8.6 Factors influencing corrosions.
8.7 Protection against corrosion.

List of Practicals:

1. Preparation of one organic compound.
2. Preparation of one inorganic complex.
3. Estimation of metal by complexomatric method.
4. Conduct an experiment on titration involving acid-base solution.
5. Carryout an experiment on redox titration.
6. Estimation of iron in Haematite ore.
7. Estimation of copper in brass alloy.
8. Estimation of ferrous ion in ferrous sulphate solution.
9. Determination of rate constant for chemical reactions.

Reading Lists:

Essential Reading

1. Dara, S.S. (2004), *Engineering Chemistry*. New Delhi: S. Chand and Co. Ltd.
2. Jain, P.C. & Jain, Monika. (1993), *Engineering Chemistry*(10th ed.).Dhanpat Rai Publishing Company, New Delhi.
3. Ahluwalia, V.K. & Parashar, Rakesh Kumar. (2009) *Organic Reaction Mechanisms* Narosa Publishing Chemical.

4. Murthy, N. Krishna.,Vallinayagam, P. & Madhavan, D.(2009), Engineering Chemistry (2 ed.). New Delhi: PHI publishing company.
5. Kurt, Bock. (2013). International Council of Associations;*Addressing the Avoided Emissions Challenge.*

Additional Reading

1. Lee J.D. (2008), Concise Inorganic Chemistry (5 ed,). London:Chapten and Hall, Blackwell Science Ltd.
2. Glasstone, Samuel. (1996). Physical Chemistry (4 ed.). USA: Hardcover Kriegar Publishing Company
3. Negi, A.S.& Anand, S.C. (2008). A Text Book of Physical Chemistry, NGI publisher
4. Atkins, Peter. & Paula, Julio De. Elements of Physical chemistry (4 ed.). Oxford University Press, UK.

Date: Febraury 4, 2017

Module Code and Title : EGP101 Engineering Graphics
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Ms. Yeshi Choden and Mr. Gom Dorji
Module Coordinator : Ms. Yeshi Choden

General Objective:
The module will introduce students to the fundamentals of Engineering drawing, an essential means of communication in engineering and to develop cognitive and psychomotor skills which enable them to visualize images and their dimensions. The module will also engage students to use computer graphics as a tool to define and present the object into pictorial position and transform them into technical illustration

Learning Outcomes:

On completion of the module, students will be able to:
1. Illustrate drawing layout and templates
2. Describe various drawing instruments and conventions
3. Use scales and dimensions in geometrical constructions.
4. Sketch the projections lying in different quadrants and orientations.
5. Illustrate practice perspective orthographic and isometric views of objects.
6. Demonstrate project points, lines, planes and solids.
7. Illustrate representation in first and third angle systems of projections.
8. Interpret engineering drawings.

Learning and Teaching Approach:

Lectures are used as the basic method of introducing new concepts and engineering drawings. The time allocated for these activities are given below:

Approach	**Hours per Week**	**Total Credit Hours**
Lecture	1	15
Practical	6	90
Independent study	1	15
	Total	120

Assessment Approach:

Sl. No.	*Mode of Assessment*	*Nos.*	*Marks Allocated*	*Marks (%)*
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VII	2	20	50
1.2	Assignment I: in 3rd week, Unit I-II (Present an engineering drawing illustrating sheet layout and title block with usage of	3	30	

	engineering letters. Also geometrical construction and construction of scales with proper dimensions). Assignment II: in 7th week, Unit III-IV (Demonstrate orthographic projection of points, lines and planes in four different quadrants). Assignment III: in 10th week, Unit V-VII (Analyse and demonstrate perspective view of different solid object, sectioning of solid and interpret isometric and orthographic drawing). Assessment Criteria (Assignment): • Title block. • Neatness. • Completeness of problems. • Drawn on scale and dimensions shown.		(10)x3 2 1 6 1	
2	Semester End Examination: 4 hours, closed book.	1	50	50

Pre-requisites: None

Subject Matter:

Unit I: General

1.1 Importance, significance and scope of engineering drawing, lettering.
1.2 I.S. drawing conventions- line symbols, kinds of line, drawing sheet lay-out, rules of printing, sense of proportioning.

Unit II: Size Description

2.1 Tools of dimensioning, size and location dimensions.
2.2 Principles and conventions of dimensioning, types of scales and their construction and uses, preferred scales.

Unit III: Projection of Points and Lines

3.1 Introduction to planes of projection, reference and auxiliary planes.
2.3 Projections of points and lines in different quadrants, traces, inclinations, and true lengths of the lines.
2.4 Projections on auxiliary planes, shortest distance intersecting and non-intersecting lines.

Unit IV: Projections of Planes

4.1 Different cases of plane figures (of different shapes) making different angles with one or both reference planes and lines lying in the plane figures making different given angles (with one or both reference planes).
4.2 Obtaining true shape of the plane figure by projection.

Unit V: Projection of Solids

5.1 Projection of simple solids - prisms, pyramids, cylinders, cones and spheres with simple cases when solid is placed in different positions w.r.t. axis, faces and lines lying in the faces of the solid making given angles.

Unit VI: Sections of Solids

6.1 Importance of sectioning, principles of sectioning, types of sections, cutting plane representation, section lines, and conventional practices.

Unit 7: Projections

7.1 Perspective, orthographic, isometric and oblique projections, isometric scale, isometric drawing.
7.2 Representation in first and third angle systems of projections.

Reading Lists

Essential Reading:

1. Bhatt, N.D. and Panchal, V.M. (2002). *Engineering Drawing- Plain and Solid Geometry*. New Delhi: Charotar Publishing House.
2. Narayana, K.L. and Kannaiah, A. (2006). *Text Book on Engineering Drawing: Engineering Graphics*. New Delhi: Tata McGraw Hill Publishing Company Ltd.
3. Venugopal, K. (2006). *Engineering Drawing and Graphics*. New Delhi: New Age International Publishers.

Additional Reading:

1. Shah, P.J. (2009). *Text Book ofEngineering Drawing*. New Delhi: S. Chand & Company Ltd.
2. Dhawan, R.K. *Text Book of Engineering Drawing.* New Delhi: S. Chand & Company Ltd.
3. IS: 696 – 1972, *Code of Practice for General Engineering Drawing*. New Delhi: Bureau of Indian Standards.
4. Jolhe, D.A.(2007). *Engineering Drawing: with an Introduction to CAD*. New Delhi: Tata McGraw Hill Publishing Company Ltd.

Date: February 4, 2017

BE (First Year) – Second Semester

Semester II				Contact Hours			Marks		
							Theory		Pract
#	Code	Module	Credit	L	T	P	CA	EX	CA
1	MAT102	Engineering Mathematics-II	12	4	1	0	30	70	0
2	DZG101	Dzongkha for Communication	12	2	1	0	50	50	0
3	ACS101	Academic Skills	12	3	1	0	100	0	0
4	TSM101	Engineering Mechanics	12	3	1	2	25	50	25
5	BPD101	Building Materials and Construction	12	3	1	2	25	50	25
Total				**15**	**5**	**4**	**230**	**220**	**50**
			60	**24**			**500**		

Module Code & Title : MAT102 Engineering Mathematics-II
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mrs.Jyothi Lakshmi S, Ms. Tshering Denka and Mr. Jigme Namgyal
Module Coordinator : Jyothi Lakshmi S

General Objective:

The module aims to build upon the knowledge and skills that students would have gained from the first Engineering Mathematics module of the programme. In particular, the module focuses on the concepts of

Vector calculus, Multiple Integrals and Differential Equations to help students apply these concepts in various fields of engineering.

Learning Outcomes:

On completion of the module, students will be able to:

1. Explain and differentiate between Rectangular, Spherical and Cylindrical co-ordinate systems.
2. Find the shortest distance between two lines, intersection of two or more planes, and the intersection of a sphere and a plane.
3. Determine the consistency of linear equations.
4. Determine the characteristic equation and Eigen vectors and explain the properties of Eigen values.
5. Differentiate between Scalar point functions, vector point function, and the operator Del.
6. Find divergence and curl of a function.
7. Integrate a vector point function.
8. Apply Green's Theorem and Stokes Theorem.
9. Use Multiple Integrals to determine the volume of solids, area of curved surface, centre of Gravity and Moment of inertia.
10. Solve Linear Differential Equations of higher order and simultaneous linear differential equations with constant coefficients.
11. Apply the concept of LDE in simple Harmonic motion and simple pendulum.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	4	60
Tutorial	1	15
Independent study/self-directed learning	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit III Term Test II: in 10th week, Unit IV	2	20	30
1.2	Tutorial Test: Closed book, One test each after completion of every topic.	4	6	
1.3	Assignment I: in 7th week, Unit III (Apply Green's Theorem and Stokes Theorem). Assessment criteria Presentation(0 .5 Marks) Procedure (1.0 Marks) Final answer (0.5 Marks)	1	2	
1.4	Assignment II: in 13th week Unit IV (Determine the volume of solids, area of curved surface, centre of gravity and moment of inertia). Presentation(0 .5 Marks) Procedure (1.0 Marks) Final answer (0.5 Marks)	1	2	

2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisite: None

Subject Matter:

Unit I: Coordinate Geometry of Three Dimensions: Rectangular Coordinate System

1.1 Introduction.
1.2 Cylindrical and spherical coordinate system.
1.3 The plane, the straight line, intersection of line and a plane, shortest distance between two lines.
1.4 Intersection of two or more planes, the sphere, Tangent plane, Intersection sphere and a plane, radical plane, cones, cylinder.

Unit II: Matrices

2.1 Elementary transformations of a matrix, Elementary matrices, Normal form of a matrix.
2.2 Linear dependence of vectors, consistency of a system of linear equations, linear transformations, orthogonal transformations characteristic equation.
2.3 Eigen vectors, properties of Eigen values.
2.4 Caley-Hamilton theorem Reduction to diagonal form.
2.5 Reduction of a quadratic form to canonical form.
2.6 Complex matrices.
2.7 Conjugate of a matrix.
2.8 Hermitian matrix, skew Hermitian matrix: unitary matrix.

Unit III: Vector Calculus

3.1 Differentiation of Vectors, curves in space, velocity and acceleration.
3.2 Relation of Velocity and acceleration.
3.3 Scalar and vector point functions-vector operator “del”:
  3.3.1 Del-application to scalar point functions. Gradient.
  3.3.2 Del-application to vector point functions.
  3.3.3 Divergence and curl.
  3.3.4 Physical interpretation of divergence F and curl F.
  3.3.5 Del applied twice to point functions.
  3.3.6 Del applied to product of point functions.
3.4 Integration of vectors line integral-circulation-wirk.
3.5 Theorems:
  3.5.1 Surface integral-flux Greens theorem in plane.
  3.5.2 Stoke’s theorem.
  3.5.3 Volume integral.
  3.5.4 Divergence theorem in rotational and solenoidal fields, “Greens Theorem” Gauss Theorem.
3.6 Orthogonal curvilinear coordinates.
  3.6.1 Del applied to functions in orthogonal curvilinear coordinates cylindrical coordinates.
  3.6.2 Spherical and polar coordinates.

Unit IV: Multiple Integrals

4.1 Double integral.
4.2 Change of order of integration Double integrals in polar coordinates.
4.3 Areas endorsed by plane curves.
4.4 Triple integrals.
4.5 Volumes of solids.
4.6 Change of variables.

4.7 Area of a curved surface, calculation of mass.
4.8 Centre of gravity, centre of pressure, moment of inertia.

Unit V: Linear differential equation of higher order and its applications

5.1 Definitions.
5.2 Complete solution.
5.3 Operator, Rules for finding complementary functions, inverse operator.
5.4 Rules for finding particular integral:
  5.4.1 Working procedure.
  5.4.2 Method of variation of parameters Cauchy's and legendries linear equations.
  5.4.3 Simultaneous linear equations with constant coefficients.
5.5 Applications:
  5.5.1 Introduction.
  5.5.2 Harmonic motion oscillation of a spring.
  5.5.3 Simple pendulum.

Reading Lists:

Essential Reading:

1. Kreyszig, E. (2011). Advanced Engineering Mathematics (10 ed.). Singapore: John Wiley & Sons (Asia) Pvt Ltd.
2. Grewal, B. S. (2013). Higher Engineering Mathematics (43 ed.). New Delhi: Khanna Publishers.
3. Dass, H. K. (2008). Advanced Engineering Mathematics (19 ed.). New Delhi: S.Chand& Company Ltd.
4. Jain, R. K., & Iyengar, S. R. K. (2007). Advanced Engineering Mathematics (3 ed.). New Delhi: Narosa Publishing house.
5. Prasad, I. B. (1982). Practical Mathematics Vol I and Vol II (6 ed.). New Delhi: Khanna Publishers.

Additional Reading:

1. Vasishtha, A. R. (2002). Matrices (32 ed). Meerut: Krishna Prakashan Media (P) Ltd.
2. Bali N.P &cDr. Manish Goyal (2014) A Text Book of Engineering Mathematics (9 ed). New Delhi: Laxmi Publications(P) Ltd.
3. Babu Ram, (2010), Engineering Mathematics (1 ed). New Delhi : Pearson

Date: Febraury 4, 2017

སྒོང་ཚན་འགྲེལ་བཤད།

༡ སྒོང་ཚན་གྱི་མིང་ ： རྫོང་ཁ་བརྡ་དོན་སྒྲིད་ལེན།

༢ སྒོང་ཚན་ཨང་ ： རྫོང་ཁ་༡༠༡ (DZG 101)

༣ སློབ་སྒོང་གྱི་ཆ་ཚིད་ ： གཙུག་ལག་གཞི་རིམ་འོག་མའི་སློབ་སྒོང་དང་གཙུག་ལག་གཞི་རིམ་སློབ་སྒོང་།

༤ སྒོང་འཐུས་ ： ༡༢

༥ སློབ་སྟོན་པ་ ： རྫོང་ཁའི་ལེགས་བཤད་པ།

༦ སྤྱིར་བཏང་གི་ལས་དོན་ ：

རྩོང་ཁ་བརྡ་དོན་སྤྲོད་ལེན་གྱི་སྐྱོང་ཚན་འདི་མཐར་འཁྱལ་ཞིནམ་ལས་xliiiསྒོ་སྐྱོང་པ་ཚུ་གིས་རང་གི་མི་ཚེ་ནང་xliiiལྟ་གཡོག་དང་འབྲེལ་བའི་xliiiགནད་དོན་ག་ཅའི་ཐད་ལས་འབད་རྒྱུ་རྩོང་ཁའི་ནང་དགོ་ཐོག་ཡིག་ཐོག་གཉིས་ཆ་རའི་ནང་བརྡ་དོན་སྤྲོད་ལེན་ཚུལ་དང་མཐུན་ཏོག་ཏོ་འབད་འབད་ཚུགས་ནི།

༧ སྒོ་སྐྱོང་གྲྭབ་འབྲས།

སྐྱོང་ཚན་འདི་ལྟབ་ཚར་བའི་ཤུལ་ལུ་སྒོ་སྐྱོང་པ་ཚུ་གིས་ ：

༧.༡ རྩོང་ཁའི་སྐད་ཡིག་གི་འབྱུང་རབས་དང་རྩོང་ཁ་ལྟབ་དགོ་པའི་ཁུངས་དང་དགོས་པ་ཚུ་སྒྲུབ་ཚུགས

།

༧.༢ དུས་རྒྱུན་ལག་ལེན་འཐབ་དགོ་པའི་མིང་བྱ་ཚོག་ཁད་ཚོག་ཚོག་གྲོགས་ཚུ་མ་འཛོལ་བར་ལག་ལེན་འཐབ་ཚུགས།

༧.༣ དུས་རྒྱུན་ལག་ལེན་འཐབ་དགོ་པའི་མིང་བྱ་ཚོག་ཁད་ཚོག་ཚོག་གྲོགས་ཚུ་གི་ཡིག་སྟེབ་ དཔེ་འབད་འཁྲི་ཚུགས།

༧.༤ ཡུལ་དུས་གནས་སྟངས་དང་བསྟུན་ཏེ་ཞེ་ས་དང་ཐལ་སྐད་ཚུལ་མཐུན་འབད་ལག་ལེན་འཐབ་ཚུགས།

༧.༥ རྩོང་ཁའི་ཐོག་ལུ་བྱིས་ཏེ་ཡོད་མི་ཚུ་ཚུལ་དང་ལྡན་ཏོག་ཏོ་འབད་ལྟག་ཚུགས།

༧.༦ རྫང་མོ་དང་བློ་ཟེ་དཔེ་གཏམ་གྱི་རིགས་ཚུ་ལག་ལེན་འཐབ་ཚུགས།

༧.༧ འབྲེལ་སྦྲ་དང་བྱེད་སྦྲ་ལྟག་བཅས་རྒྱུན་སྤྱད་ཀྱི་ཚོག་ཐུད་ཚུ་མ་འཛོལ་བར་ལག་ལེན་འཐབ་ཚུགས།

༧.༨ འབྱི་རྩོམ་གྱི་ཁད་ཆོས་ཚུ་ཚངམ་འབད་ལག་ལེན་འཐབ་སྤེ་འབྱི་ཚུགས།

༧.༩ གཞུང་སྐེར་ཡིག་འཐུལ་གྱི་རིགས་འབྱི་ཚུགས།

༧.༡༠ འབྱི་ཨོག་གི་རིགས་གཅི་རྣ་ཙིན་རྫང་རྩོང་གའི་ནང་དཀའ་ངལ་མེད་པར་བཀང་ཚུགས།

༧.༡༡ ལུང་འདེན་དང་རྒྱབ་རྟེན་གྱི་ཐོ་འོས་འབབ་ལྟན་ཏོག་ཏོ་འབད་བཀོད་ཚུགས།

༨ རིག་རྩལ་ཡར་རྒྱས་ ： རྩོང་ཁའི་སྐད་ཡིག་གི་རིག་རྩལ་བཞི།

༩ གནས་ཚད་ ：

༡༠ སྒོ་སྐྱོན་འབད་ཐངས ：

སྤྱོང་ཚན་འདི་གི་དོན་ལུ་ཡོངས་བསྡོམས་ཆུ་ཚོད་༡༡༠ཐོག་དགོས་ཤེན་རྩུལ་རྒྱུན་སྒྲིབ་ཁང་ནང་སྒྲིབ་སྐྱོན་གྱི་དོན་ལུ་ཉུང་མཐའ་ཆུ་ཚོད་༤༠དགོས་ཤེན།xliiiདེ་ཡང་བདུན་ཕྲག་རེ་ལུ་ཆུ་ཚོད་ ༤རེ་འབད་བདུན་ཕྲག་ ༡༤གི་རིང་ལུ་སྒྲིབ་སྐྱོན་འབད་དགོས་ཤེན།xliiiདེ་གི་ལྟག་མ་ཆུ་ཚོད་ ༤༠སྒྲིབ་ཁང་ནང་འབད་མེན་པར་རང་ཉིད་རྒྱུ་བའི་སྒྲིབ་སྐྱོན་འབད་དགོས་ཤེན།xliiiཏུས་རྒྱུན་སྒྲིབབ་ཁང་ལུ་སྒྲིབ་སྐྱོན་འབད་བའི་སྐབས་ལུ་འོག་གི་ཆུ་ཚོད་དམྱ་བགོ་རྒྱབ་མི་དང་འཁྲིལ་ཏེ་

ལག་ལེན་འཐབ་དགོ

སྒྲིབ་སྐྱོན་ ཆུ་ཚོད་ ༡༠

སྤྱོང་ལྟ ཆུ་ཚོད་ ༣༠

སྤྱན་ཞུ་ ཆུ་ཚོད་ ༡༠

༡༡ དབྱེ་ཞིབ་ ： སྤྱོང་ཚན་འདི་གི་དོན་ལུ་སྤྱང་རྒྱས་དབྱེ་ཞིབ་དང་དུས་རྒྱུན་དབྱེ་ཞིབ་གཉིས་ཆ་ར་ལགཔ་སྟེ་དབྱེ་ཞིབ་འབདཝ་ཨིན།

ཀ　དུས་རྒྱུན་དབྱེ་ཞིབ།སྐྱེས་༥༠%

ལས་འགྱུལ་　　༢༠%

སློབ་ཁང་སྤྱན་ལྟ་　　༡༥%

སློབ་ཁང་གི་སྤྱོང་ལྟ་　　༡༥%

ཁ་　སྤྱང་རྒྱས་དབྱེ་ཞིབ།　༥༠%

ཆོས་རྒྱུགས།　　༥༠%

ཡོངས་བསྡོམས་སྐྱེས་　**༡༠༠**

༡༢ སྡེན་ཚང་ཤེས་ཡོན་ ：

༡༣ ནང་དོན་

དོན་ཚན་ཀ་པ།　སྐད་ཡིག་གྱི་ངོ་སྤྲོད།　(ཆུ་ཚོད་༣)

༡ རྩོང་ཁའི་སྐད་ཡིག་གི་འབྲུང་རབས།

༢ རྩོང་ཁ་ལྷབ་དགོ་པའི་དགོས་པ།

དོན་ཚན་ཁ་པ།　མིང་ཚིག་བརྗོད་པའི་རྣམ་གཞག　(ཆུ་ཚོད་༢༥)

༡ མིང་།

༢ བྱ་ཚིག་

༣ ཁྱད་ཚིག་

༤ ཚིག་གྲོགས།

༥ རྩོང་ཁ་དག་གཤིས་འགྲོ་ལུགས།

༦ སྐྱན་རྩོམ།　དཔེ་གཏམ།　བློ་ཟེ།　རྩང་མོ།

༧ རྩོང་ཁ་ཁ་ཉག་རྒྱང་གི་མིང་ཚིག་ལགཔ་ལེན་འཐབ་ཐངས།

༨ མིང་ཚིག་དང་བྱ་ཚིག་ཁྱད་ཚིག་ཆུ་འོས་འབབ་ལྟནམ་འབད་ལགཔ་ལེན་འཐབ་ཐངས།

དོན་ཚན་གཉིས་པ།　རྩོང་ཁའི་དག་གཤིས་དང་འཁེལ་ཏེ་ལྷག་ཐངས།　(ཆུ་ཚོད་༩)

༡ ཚིག་མཚམས་བཅད་དེ་ལྷག་ཐངས།

༢ རྗེས་འཇུག་གི་སྒྲ་ཧྲིལ་བུ་བཏོན་དགོ་པ་དང་མ་དགོ་པའི་རིགས་ཆུ་ཁྱད་པར་ཕྱེ་སྟེ་ལྷག་ཐངས།

༣ རྗེས་འཇུག་མེད་རྒྱང་ཡོད་པ་བརྒྱམ་ལྷག་ཐངས།

དོན་ཚན་ང་པ། ཡི་གུའི་སྒྱོར་བ། (ཆུ་ཚོད་༤)

༡ འབེལ་སྒྲ།

༢ ཟེད་སྒྲ།

༣ ལྷག་བཅས།

༤ རྒྱན་སྤྲད།

དོན་ཚན་ཅ་པ། ཡིག་འགྲུལ། (ཆུ་ཚོད་༡༠)

༡ ཡིག་ཆུང་འབྲི་ཐངས།

༢ མཐོན་ཞུ་འབྲི་ཐངས།

༣ གཏང་ཡིག་འབྲི་ཐངས།

༤ ཞུ་ཡིག་དང་ཞུ་ཚོགཀ/བཤེར་ཡིག་འབྲི་ཐངས།

༥ གན་ཡིག་འབྲི་ཐངས།

༦ སྐན་ཞུ་འབྲི་ཐངས།

༧ གྲོས་ཆོད་འབྲི་ཐངས།

༨ ཁྲབ་བསྒྲགས་ཀྱི་རིགས་འབྲི་ཐངས།

༩ འབྲི་ཤོག་གི་རིགས་བཀང་ཐངས།

༡༠ འབྲི་རྩོམ་འབྲི་ཐངས།

༡༡ ཚག་ཤད་ལག་ལེན་འཐབ་ཐངས།

༡༢ ལུང་འདེན་དང་རྒྱབ་ཏེན་གྱི་དཔེ་ཐོ་བགོད་ཐངས།

དོན་ཚན་ཆ་པ། སྐད་སྒྱུར།

༡༩ ལྷག་དགོ་པའི་དཔེ་ཐོ།

ཀ སྒྱོང་ཚན་འདི་སྦྱང་བ་ལེགས་ཤོམ་འབད་ཐོབ་ནི་དོན་ལུ་འོག་ལུ་བཀོད་དེ་ཡོད་མའི་དཔེ་དེབ་ཚུ་ངེས་པར་དུ་ལྷག་དགོ

ཀུན་བཟང་རྡོ་རྗེ། (༡༥༡༡) བློ་ཟེ་ལྷའི་པི་ཕང་། ཐིམ་ཕུ། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས།

ཀུན་བཟང་རྡོ་རྗེ། (༡༥༡༡) རྩང་མོའི་ཀྱི་དེབ་བློ་རིག་མེ་ཏོག ཐིམ་ཕུ། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས།

ཀུན་བཟང་འཕྲིན་ལས། (༡༠༠༧) ཡིག་བསྒྱང་རྣམ་གཞག་གི་དེབ། ཐིམ་ཕུ། ཀེ་ཛེམ་ཀྱི།

སྐལ་བཟང་ཆོས་འཕེལ་དང་ཆ་རོགས་ཚུ། (༡༥༡༣) ཉེ་འབེལ་མིང་ཚིག་རབ་འཛུད། ཐིམ་ཕུ། ཞིས་ཀྱ་གྲེན་པ་ལྟས།

རྣམ་རྒྱལ་དབང་ཕྱུག (༡༠༠༧) རྩོང་ཁའི་ཚད་ལྡན་སྐྱེན་ཞུ་དང་ཡིག་རིགས་འབྲི་ཐངས། ཐིམ་ཕུ།

རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས། (༢༠༡༡) ཕལ་སྐད་ཞེ་སའི་རྣམ་གཞག་སྐར་མའི་འོད་ཟེར། ཐིམ་ཕུ། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས།

རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས། (༢༠༡༩) འབྲུག་གི་ཡིག་བསྒྱུར་རྣམ་གཞག ཐིམ་ཕུ། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས།

རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས། (༢༠༠৮) རྩོང་ཁའི་བརྡ་གཞུང་གསར་པ། ཐིམ་ཕུ། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས།

བསམ་གྲུབ་ཆེ་རིང། (༢༠༠৯) ཡ་རབས་ལམ་དུ་འདེན་པའི་ཕལ་སྐད་དང་ཞེ་སའི་དེབ་ཆུང་། (ཁ་གསལ་མེད)

ཁ་ འོག་ལུ་བགོད་མི་དུས་དེབ་ཚུ་ཁ་སྐོང་གི་གནས་ཚུལ་ཐོབ་ནིའི་དོན་ལུ་ལྷག་དགོཔ་ཨིན།

ཀུན་ལེགས་རྒྱལ་མཚན། (༢༠༠৬) རྩོང་ཁའི་བྱེད་སྒྲ། ཐུ་རེ།

སྐལ་བཟང་དབང་ཕྱུག (༢༠༠৭) རྩོ་ཁ་བརྡ་དོན་རྒྱུན་འབེལ། བསམ་རྩེ།

བྱམས་པ་ཆོས་རྒྱལ། (༡৮৮৮) སུམ་ཅུ་པའི་རྣམ་བཤད། ཐིམ་ཕུ། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས།

རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས། (༡৮৮০) ཆོག་དོན་ཀུན་གསལ་མེ་ལོང་། ཐིམ་ཕུ། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས།

རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས། (༡৮৮৮) འབྲི་རྩོམ་སྦྱོགས་དེབ། ཐིམ་ཕུ། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས།། (༡৮৮০) རྩོང་ཁ་རབ་གསལ་ལམ་བཟང་། ཐིམ་ཕུ། རྩོང་ཁ་གོང་འཕེལ་ལྷན་ཚོགས།

རིན་ཆེན་མཁའ་འགྲོ། (༡৮৮২) རྩོང་ཁ་དབྱིན་སྐད་ཆོག་མཛོད།

བསོད་ནམས་བསྟན་འཛིན། (༢༠༠২) ལོ་འཁོར་བཅུ་གཉིས་ཀྱི་ཨཁད་པ། ཐིམ་ཕུ། ཀེ་ཛེམ་ཀྱི་ལས་སྡེ།

༡৫ བསྒྲུར་ཞིབ་འབད་བའི་ཆོས་གྲངས་ ： ༢৬/০২/২০১৯ལུ།

Module Code & Title **: ACS101 Academic Skills**
Programme **: RUB-wide module**
Credit **: 12**
Module Tutor **: Mrs. Chencho Dema and Pema Choezom**
Module Coordinator **: Mrs. Chencho Dema**

General Objective:

The Academic Skills module is designed to support students in their learning and provide generic skills that are required for university study. The focus will be on developing the skills of academic writing, oral presentation, and research skills, which will be delivered through classroom instruction, as well as through course work.

Learning Outcomes:

On completion of the module, students will be able to:

1. Communicate effectively in both spoken and written academic forms.
2. Select relevant information from a range of textual formats and synthesize through note taking, summarizing and paraphrasing and reformulate it in written and spoken form.
3. Read texts at a variety of levels by applying skimming and scanning techniques, and reading for detailed understanding.
4. Evaluate the credibility of sources (i.e. by author, publisher or website).
5. Organise writing according to purpose of writing and text types through planning, organizing ideas, structuring, synthesizing, editing and proofreading.

6. Develop own arguments and integrate these appropriately with source material in written and spoken form in line with the concepts of academic integrity.
7. Cite sources and create a reference list using APA style.
8. Deliver a formal academic oral presentation.
9. Critically reflect on their own learning by organizing their learning and monitoring its progress by maintaining a portfolio.
10. Appreciate and develop personal skills such as cooperation, negotiation, group work, and leadership.
11. Develop an independent approach to studying.

Learning and Teaching Approach:

Tutors will employ an interactive, student-centred approach, integrating language and critical thinking skills using the following strategies over the 60 hours of contact time.

1. Demonstrations/Modelling (3 hours)
2. Practical exercises and activities/Task-based learning (18 hours)
3. Individual, pair and group work (e.g. Discussions, problem-solving activities, collaborative and individual tasks, peer feedback, debates, role-plays, etc.) (18 hours)
4. Process learning, with diagnosis, feedback and remediation (e.g., with portfolio tasks) (15 hours)
5. Presentations (6 hours)

Assessment Approach:

Since this module is entirely assessed through coursework, a student must complete all 4 components of the assessment outlined below (portfolio; 2 class tests; presentation; essay) and get an aggregate mark of 50% in order to pass.

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	A Portfolio of work done in class and as homework	1	25	100
1.2	Class Tests	2	30	
1.3	An Oral Presentation	1	15	
1.4	A Researched Assignment (essay)	1	30	

Pre-requisite: None

Subject Matter:

Unit1:Academic Standard Ethics (5 hours)

1.1. Purpose of academic activity
1.2. Features of academic writing
1.3. academic argument and academic integrity

Unit 2: Note-taking (6 hours)

2.1. Basics of note-taking
2.2. Types of notes, strategies and activities
2.3. Listening and note-taking

Unit3:Academic Reading (13hoours)

3.1 Identify text features & organization
3.2 Reading Techniques(skimming/scanning, SQ3R)
3.3 Locating, evaluating and selecting information

3.4 Summarising / paraphrasing academic texts
3.5 Critical reading(author viewpoints/biases, reading for detail)

Unit4:Academic Essay Writing(14hours)

4.1 Introduction to the Writing Process
4.1.1 pre printing(gatheringinformation;brainstorming;planningandoutlining);drafting(writing);
4.1.2 revising & editing/proofreading;
4.1.3 publishing
4.2 Understanding & analysing assigned topics/directions (BUG); using the writing process
4.3 Essay Format/Structure
4.3.1 Introduction & Thesis statement
4.3.2 Body paragraphs(topic sentences; supporting sentences with evidence /examples/explanation/etc.; concluding sentences/ transitions; cohesive devices)
4.3.3 Conclusion

Unit5: Referencing Techniques and APA format (10hours)

5.1 Introduction to using source materials what are sources?, relevant terms, introduction to paraphrasing source material
5.2 Academic integrity and referencing
5.3 Locating, Evaluating and Selecting Sources
5.4 Using source materials for in-text citation
5.5 Making end-text/reference lists
5.6 Avoiding plagiarism

Unit6: Oral Presentations (10hours)

6.1 Introduction to academic argument in oral settings and presentations
6.2 Strategies for delivering an effective presentation structure, signposting

Unit7: Types of Writing (2hours)

7.1 Reflective writing or Report writing
7.2 Or any other writing genres relevant to colleges: e.g., proposals/business plans, lab reports, and other technical writing types

Reading Lists:

Essential Reading

1. Teacher materials for the Academic Skills module(January, 2013).
2. Student materials for the academic skills module(January, 2013).
3. AmericanPsychologicalAssociation. (2010).PublicationManualoftheAmericanPsychologicalAssociation.(6 ed.).Washington,DC:AmericanPsychologicalAssociation.
4. Anderson,K.,Macclean,J.,&Lynch,T.(2007). Study speaking:AcourseinspokenEnglishforacademicpurposes(2ed.).Cambridge:CambridgeUniversityPress.
5. Bailey,S.(2011).Academicwriting:Ahandbookforinternationalstudents(3ed.).Abingdon, Oxford: Routledge.

Additional Reading

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2. Butler,L. (2007).Fundamentalsofacademicwriting.NewYork: Pearson Longman.
3. Cottrell,S.(2008). The study skills handbook(3ed.).NewYork:PalgraveMacmillan.
4. Cottrell,S.(2011)Criticalthinkingskills:Developingeffectiveanalysisandargument. (2ed.). Basingstoke: PalgraveMacmillan.
5. Cox, K.,&David,H.(2007).EAPnow!:Preliminarystudent book.N.S.W.,Australia:PearsonLongman.

6. Cox,K.,&David,H.(2010). EAPnow: Englishforacademicpurposes.Teacher'sbook. (2ed.). N.S.W., Australia: PearsonLongman.
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9. Craven,M.(2008).CambridgeEnglishskillsreallisteningandspeaking3with answersandaudioCD.Cambridge: CambridgeUniversityPress.
10. Eastwood,J.(2005).TheOxfordGuidetoEnglishGrammar.Oxford:OxfordUniversityPress.
11. Gillet,A.,Hammond,A.,&Martala,M.(2009).Insidetracksuccessfulacademicwriting.England: PearsonEducation.
12. Gillet,A.(2013, January15).UEFAP(UsingEnglishfor academicpurposes): Aguideforstudentsinhighereducation.Retrievedfromhttp://www.uefap.com
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14. Hogue,A.(2007).Firststepsinacademicwriting.NewYork:PearsonEducationESL
15. Open University(2011,July15).Learningtochange:1.4Studyskills,other skills. Retrievedfromhttp://www.open.edu/openlearn/education/learning-change/content-section-1.4
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Teacher References:

Note:Useful books for moduletutorswhileprovidingfeedbackonstudentwork.
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2. Burke,D.,&Pieterick,J.(2010).Givingstudentseffectivefeedbackwrittenfeedback. England: OpenUniversityPress
3. Frye,H.,Ketteridge,S.,&Marshall,S.(2008).Ahandbookforteachingandlearninginhighereducation:Enhancingacademicpractice.Abingdon, Oxford:Routledge.

Appendex:

2 Assessment Criteria for Final Researched Essay, Portfolio, Presentation

PORTFOLIO GRADE /25

NAME: **SECTION:** **MARKER'S INITIALS:**

	HOMEWORK & CLASSWORK /15		
13-15	**Outstanding** work throughout semester. All homework and classwork done punctually and to highest standard in terms of content, language and effort.		
11-12	**Very Good** work throughout semester. Most homework and classwork done punctually and to highest standard in terms of content, language and effort Or All homework tasks attempted to best of ability, but may have minor errors in language or content.		
9-10	**Good** work throughout semester. Most homework and classwork done punctually and to high standard in terms of content, language and effort Or Most homework tasks attempted to best of ability, but with frequent errors in language or content.		
7-8	**Satisfactory** work throughout semester. Most homework and classwork completed to minimum standard in terms of content, language and effort. There may be some missing work, late work or work of poor quality.		
4-6	**Unsatisfactory**	Unsatisfactory work over semester. Most homework and classwork incomplete or poorly completed. Or many tasks not submitted on time. *There may be repeated plagiarism /copying.*	
1-3		Very poor work throughout semester. Little classwork or homework submitted, and/or most work copied/plagiarised, and/or work completed to extremely low standard	
0	No submission		

Note that in the above table: Content refers to correctness, relevance/focus, originality of thinking; **Language** refers to accuracy and use of appropriate & formal language; and **Effort** refers to evidence of preparation, organization/neatness, avoidance of plagiarism/copying

CLASS NOTES /10	
Completeness /5	**Organisation & Clarity /5**
4-5 marks Notes are relevant, complete, include all key information and *extend well-beyond what the tutor has written on board or dictated*. Notes show clear understanding, and intelligent selection of material.	**4-5 marks** Notes are well-organized, clearly dated, with relev And useful headings. Information and topics are easy to locate. Clear la Main points and sub points or examples are easy

	distinguish. Notes are clearly distinguished from exercises.
3 marks Notes are mainly relevant and complete. They include substantial information beyond what was written on board or dictated, but they may show minor misunderstanding or irrelevancies.	**3 marks** Notes are generally organized, but headings and dates *may* be missing *at times*. Information and topics are identifiable though some effort may be required. Class notes and exercises may not always be distinguished
2 marks Notes are relevant and complete but rarely extend beyond what tutor has written on board or dictated.	**2 marks** Notes show attempt at organisation, but generally lack headings and dates. Considerable effort required to locate information.
1 mark Notes are minimal. They may be irrelevant, very difficult to understand or contain very little information.	**1 mark** Poor or no attempt at organization. Extremely difficult to identify topics or information. Headings and dates rarely present. Difficult to locate topics and information.
0 marks No relevant notes submitted	**0 marks** No relevant notes submitted

GROUP PRESENTATION ASSESSMENT CRITERIA

GROUP MARK **GROUP:**												
CATEGORY	**DETAILS**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**MARK**
CONTENT	Focus/Level of detail											
	Audience sensitivity (level/relevance of content and											

	aim)											
STRUCTURE	Coherence (including introduction, outline, signposting, recapping)											
VISUAL AIDS	Quality of aids & contribution to audience's understanding											
												+

INDIVIDUAL MARK

NAME:

CATEGORY	**DETAILS**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**MARK**
LANGUAGE	Accurate & Appropriate Language											
DELIVERY	Fluency of speech, pacing, volume, intonation											
	Body language, eye contact, independence from written text											
CLARITY	Evidence of individual's contribution											
TIME MANAGEMENT	Adherence to time guidelines											

RESPONSE TO QUESTIONS	Able to answer questions, provide clarifications on their presentation											

Under each criteria, marks signify the following performance:

10 Outstanding performance

8-9 Very strong performance, no significant improvements could be made

6-7 Good performance but still plenty of room for improvement.

5 Acceptable, but only just.

3-4 Below the minimum standard expected at college level.

0-2 Incomprehensible. *Or* the student is reading aloud. *Or* the material is memorised and clearly not the student's own.

Final Researched Essay Criteria A

Student Name: _____Student ID:_____

		1	2	3	4	5	6	7	8	9	10
1.	**Organization and Structure of Assignment (5)**										
Introduction: -States the learning goals to be addressed -Offers a brief background/rationale											
Body of text: logical development & appropriate structure											
Conclusion: offers summary of findings											
2.	**Research (10)**										
Evidence of wide reading on the topic											
Presentation of reference list											
Correctly acknowledges sources in-text											
3.	**Analysis and interpretation of source material (10)**										

Demonstrates understanding of source material	
Uses research findings to support argument & ideas	
Clarity of interpretation & analysis	
Presents own ideas	
4.	**Presentation of Writing (5)**
Appropriate use of language, clarity, expression, free of errors (e.g., spelling or other typographical errors), sentence structure	
Total Marks:	

Comments:

Examiner: **Date:**

Marking Criteria for Final Researched Essay B (Updated May 2012)

e & Quality of Answer (25%)	**Organisation & Structure (25%)**	**Use of Source Material (25%)**	**Language Use (25%)**
ng performance: a complete, relevant & in-depth answer tion sophisticated understanding of topic sufficient & relevant support for all ully communicates message throughout	**Outstanding performance**: - develops a clear, reasoned & logical argument -essay structure & paragraphing skilfully managed throughout -has clear, relevant, appropriate & linguistically accurate thesis statement & topic sentences - all content is relevant to thesis; connections between ideas & sentences clear & logical throughout	**Outstanding performance**: **-**source material used skilfully to develop own argument - sources acknowledged as necessary throughout -writer's voice leads; sources support rather than dominate - all information from sources is relevant & fully integrated into argument - correct APA style used throughout	**Outstanding performan** -uses a wide range collocation & expre sophisticated way - language is sufficient ideas -rare language e communication - uses appropriate acade
l performance: a complete & relevant answer to the thorough understanding of topic m over-generalisations evidence & support provided for claims, **rther development may be needed lly** ds in communicating message clearly, **eader effort may be required at times**	**Very good performance:** - develops a clear & logical argument; any logical flaws are minor -essay structure & paragraphing well-managed throughout -has clear, relevant & appropriate thesis statement & topic sentences, though **some *minor* linguistic errors may occur** - development of ideas generally logical & easy to follow, though some ***minor* effort on part of reader may be required *at times*** **-**	**Very good performance**: - <u>most</u> information from sources is relevant & well- integrated into argument - sources acknowledged as necessary throughout **-** material from sources is used to support own argument - APA style used throughout, though **minor mechanical errors may occur**	**Very good performanc** -the <u>majority</u> of sentenc errors / inappropriacies -uses a wide range of vo **-** makes only occasio hamper understanding **-may be some minor register**
ormance: dy answers question, though **may lack contain some irrelevant content** n adequate understanding of topic **tain *minor* over-generalisation <u>or</u> fail t some claims adequately** ds in communicating message, but **y struggle at times**	**Good performance:** - **argument / logical development** of ideas present throughout, though there **may be minor inconsistencies** - essay structure & paragraphing managed sufficiently though there may be some minor problems -**thesis statement & topic sentences present, clear & relevant, though may be linguistically inaccurate**	**Good performance**: - all sources acknowledged **-** writer's voice present throughout, but **sources may dominate at times** - **source information mainly relevant**, but **may be insufficiently integrated into argument** - APA style attempted throughout, though **frequent mechanical errors may occur in APA style** **-** may contain ***minor* distortion/ misrepresentation of source information**	**Good performance:** - sentences free of langu inappropriacies occur fr - <u>most</u> errors do not har -uses a sufficient range to communicate mess sophistication - Generally uses acade **informality / inappropri**
ry performance: nly a **partial answer to question** & / or **a significant amount of irrelevant** / or **contain some factual inaccuracy** w only a **basic understanding of topic** ain ***frequent* over-generalisation** & / or **vide adequate support for most (but**	**Satisfactory performance:** - **argument may be unclear** - **argument** / **connections between ideas present but frequently unclear** -**thesis statement & topic sentences attempted, but may not always focus sufficiently on title/question**	**Satisfactory performance**: - most source information relevant - some correct use of sources**, but may contain some uncited quotation enclosed in quotation marks; or uncited paraphrase; or paraphrase wrongly enclosed in quotation marks** **-** writer's voice present at times, but **sources**	**Satisfactory performan** - **Most sentences may** - **Language errors ma** but overall message discernable **- May be frequent in**

aims **ge** understandable, but **not clearly cated**	**-uses paragraphing, but not always logically** **- topic sentences do not develop logically from thesis statement**	**dominate** - citation attempted, but may show **little awareness of APA style** **- may use only direct quote , indicating inability to paraphrase** **-in-text and end-text citations do not fully match**	**language choices**
ctory performance: t not all, **content may be irrelevant** **ow only very basic understanding of evere misunderstandings** **tain frequent over-generalisation or r support for claims** ore than 10% above or below word limit **tain *some* plagiarism**	**Unsatisfactory performance:** - essay may be an **"information dump" where content is** **not shaped into any logical argument** - basic essay structure & paragraphing may be poor **- thesis statement & topic sentences may be off-topic /** **unclear / incomprehensible** **- topic sentences absent / unrelated to paragraph content** - may have severe **problems with logical development of** **ideas**	**Unsatisfactory performance**: -may be **no in-text citation & / or no end-text reference list ,**though source information used. - **most information** from sources may be irrelevant & / or **distorted/ misrepresented. Attempt to use sources does not strengthen argument** **- sources not used correctly anywhere within the text** **- writer's voice absent; no comment / analysis of sources** **-minimal use made of sources** or **attempts to use sources show little understanding of content** **-contains some plagiarism / patchwork (less than 20%)**	**Unsatisfactory perform** **- grammar & vocabula communicate** **- language errors message incomprehen** **- may be over-relian writer's own language** -may have very limited spelling
t answer the question / address the **e rarely discernible** **contain 20% or more plagiarised**	**- essay contains 20% or more plagiarism** –essay structure inadequate, poor or **no paragraphing** **- message rarely discernible** **-argument not present / impossible to follow**	**- contains 20% or more plagiarism** **- message rarely discernible** **- essay shows no evidence of reading or research**	**- contains 20% or more** **- message rarely disce** -uses only very basic insufficient to convey me
otally plagiarised or shows clear evidence of cheating / collusion			

IMPORTANT NOTES FOR MARKERS:

1) Begin by checking the **descriptors in bold**. They are "**ceilings"**. If you answer 'yes' to any of the bold descriptors, the student can not be given a mark higher
than that b& (e.g. if the student's essay contains 20% or more plagiarised language the *maximum* possible mark they can receive in any category is 24%. You can mark anywhere below the ceiling (in other words, between 0 & 24%)
.
2) **If the essay has not hit a "ceiling", start from the top & work down in each category.** This is important. Working from the bottom up will result in

lower
grades. **Start from bottom up to check ceilings, & then work from top down.**

3) If you can answer 'yes' to all descriptors, you are probably in the right area but check the descriptors above & below to be sure.

4) Add the total for all 4 categories & divide by 4 to calculate the percentage mark for the whole essay.

Student	
Tutor	
Module & Semester	
Grade	+ + + + = /4 =

Date: Janaury 31, 2017

Module Code & Title : **TSM101 Engineering Mechanics**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Om Kafley, Mr. Gom Dorji and Mr. Namgay Tenzin**
Module Coordinator : **Mr. Om Kafley**

General Objective:

The module aims to introduce the basic concepts of statics and dynamics under a system of forces and moments which are essential for engineering students. The knowledge and understanding, as well as the analytical tools that students acquire through this module will develop their ability to solve simple static and dynamic systems and structures. This module will also enable students to verify the principles and solve simple static and dynamic systems through experiments.

Learning Outcomes:

On completion of the module, students will be able to:

1. Determine graphically and analytically resultant of a system of coplanar concurrent and non-concurrent forces.

2. Analyse the equilibrium conditions of a body/structure under the actions of system of forces including the frictional forces, using equations of equilibrium and free body diagrams.
3. Determine the properties like centre of gravity, centroid and moment of inertia for linear elements, areas (lamina) and volumes with various reference axes of single as well as composite bodies.
4. Determine the characteristics of various lifting machines.
5. Analyse the body under motion using Newton's laws of motion, D'Alemberts principle, work – energy equations and Impulse momentum equation.
6. Determine unknown forces on a body/structure using the principle of virtual wok.
7. Verify the various laws of forces, moments and lifting machines learned in theory through experiments.
8. Use laboratory equipment and tools correctly and safely, to make measurements.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Practical	2	30
Tutorial	1	15
Independent study/self-directed learning	2	30
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I : in 5th week Unit I-IV Term Test II : in 10th week,Unit V-VIII	2	20	25
1.2	Assignment I: in 7th week, Unit I-V (Analysis of forces problems). - Conceptual Understanding : 1 - Application of the Concept : 1 - Accuracy and correctness : 0.5 Assignment II: in 12th week, Unit VI-VIII (Analysis of motion). Late submission: deduct 0.5 marks per day. - Conceptual Understanding : 1 - Application of the Concept : 1 - Accuracy and correctness : 0.5	2	5	
2	Continuous Assessment (Practical)			
2.1	Regular assessments: Assessment criteria (Lab Report)	1	10	25

	• Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).		1 3 2 2 2	
2.2	Practical examination: 2 hours, closed book.	1	10	
2.3	Viva-voce:	1	5	
3	Semester End Examination: 3hours, closed book.	1	50	50

Pre-requisites: None

Subject Matter:

Unit I: Fundamental Concept

1.1 Fundamental laws of mechanics, scalar and vector quantities.

Unit II: Composition and Resolution of Forces

2.1 Explain Composition and Resolution of forces.
2.2 Find resultant using Analytical and graphical method.
2.3 Composition of forces by Resolution.

Unit III: Moments and Couples

3.1 Moment of force and Varignon's theorem.
3.2 Couple and resultant of a force system.
3.3 Type of levers.

Unit IV: Equilibrium

4.1 Equilibrium of a body, Equilibrant.
4.2 Type of forces on a body, Free Body Diagrams.
4.3 Lami's theorem.
4.4 Equilibrium of connected bodies, Equilibrium conditions.
4.5 Reaction, loading and support of beams.

Unit V: Friction

5.1 Frictional force and laws of frictions.
5.2 Angle of friction, angle of cone, angle of repose.
5.3 Wedges, Rope friction, Non-concurrent force problems.

Unit VI: Centre of Gravity and Moment of Inertia

6.1 Centre of gravity, Centre of gravity of a flat plate and solid, centroid, axis of symmetry.
6.2 Centre of gravity from first principal and centre of composite section.
6.3 Moment of inertia, Polar moment of inertia and Radius of gyration.
6.4 Theorems of moment of inertia, moment of inertia from first principle, moment of inertia of standard section and composite section including the mass moment of inertia.

Unit VII: Principle of Lifting Machines

7.1 Law of machine, Mechanical advantage.
7.2 Differential wheel and axle, winch crab (single and double), worm and worm wheel, inclined plane.

Unit VIII: Linear Motion, Motion of Rotation and Translation

8.1 General principle of dynamics, type of motion.
8.2 Newton's law of motion I, II, and III, D' Alembert's principle.
8.3 Work, power and energy, Work-energy equation, Work done by a spring.
8.4 Impulse momentum equation, conservation of momentum, pile and hammer.
8.5 Kinematics of motion of rotation, Angular momentum and its application.
8.6 Acceleration during circular motion, motion on level road, designed speed, skidding and overturning.
8.7 Angular motion, kinetic energy of rotating bodies, relation between angular motion and linear motion.
8.8 Motion of connected bodies.
8.9 Combined motion of rotation and translation.

Unit IX: Virtual Work

9.1 Principle of Virtual Work.
9.2 Application of the principle of virtual work to determine unknown forces.

List of Practicals:

1. Verification of Triangle law of forces.
2. Verification of Polygon law of forces.
3. Verification of Parallelogram law of forces.
4. Determine the Co-efficient of Friction for rolling and sliding friction for different surfaces.
5. Determination of Law of Machine for Worm and Worm Wheel, Single Purchase Winch Crab, Differential Wheel and Axle.
6. Verify Principle of Moment.

Reading Lists:

Essential Reading

1. Meriam, J. L. & Kraige, L. G. (2013). Engineering Mechanics - Statics (7 ed.). New Delhi: Wiley India.
2. Bhavikatti, S. S. & Rajashekarappa, K. G. (2004). Engineering Mechanics. New Delhi: New Age International Publishers.
3. Timoshenko, S. & Young, D. H. (2006). Engineering Mechanics. New Jersey: McGraw Hill Publications.
4. Hibbeler, R. C. (2013). Engineering Mechanics-Statics (13 ed.). New Jersey: Pearson Prentice Hall, Pearson Education.
5. Kumar, K. L. (1998). Engineering Mechanics. New Delhi: McGraw Hill.

Additional Reading

1. Malhotra, D. R. & Gupta, H. C. (1998). Applied Mechanics & Strength of Materials. New Delhi: Satyaprakashan Publishers,
2. Shigley. (2000). Applied Mechanics of Materials. New Delhi: McGraw Hill Publications, International Student Edition.
3. Khurmi, R. S. (2002). Text Book of Engineering Mechanics. New Delhi: S.Chand& Co.
4. Sinha, N. C. & Sen Gupta, S. K. (1987). Elements of Structural Mechanics. New Delhi: S.Chand& Co.
5. Junarkar, S. B. (1991). Elements of Applied Mechanics. New Delhi: Charotar Publications, Anand.
6. Ramamrutham, S. (2001). A Text Book of Applied Mechanics. New Delhi: Dhanpat Rai Publications.
7. Malhotra, M. M. etc. Al. (1994). A Text Book in Applied Mechanics. New Delhi: New Age International Publishers.
8. Shames, Irving. H. (1996). Engineering Mechanics–Statics & Dynamics. New Delhi: Prentice Hall India.

Date: Janaury 31, 2017

Module Code & Title : BPD101 Building Materials and Construction
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mr. Ugyen Dorji and Ms. Yeshi Choden
Module Coordinator : Mr. Ugyen Dorji

General Objective:

The aim of this module is to provide students with the knowledge and understanding of the different types of building materials and their application in constructions. This module also intends to equip students with the knowledge of the various methods applied in building constructions.

Learning Outcomes:

On completion of the module, students will be able to:

1. Distinguish the types and properties of stones, bricks, timber, metals (ferrous and non-ferrous), glasses, damp proof materials, glass, paints and their applications in the building industry.
2. Explain the characteristics of concrete ingredient materials and their influence on the properties of concrete, types, production of concrete, important characteristics of concrete and the quality control measures through destructive and non-destructive tests.
3. Express the need for the building bye-laws and the local building bye-laws.
4. Explain the various types of foundations and their suitability, and selection criteria for a particular building.
5. Identify the various types of stone masonry and their suitability, and the construction methods including quality control measures (guidelines for supervision).
6. Identify the various types of brick masonry (brick bonds), construction methods and their suitability.
7. Indicate the various types of floors, their construction details, and selection criteria.
8. Translate the various types of roofs, roof coverings, doors, windows, stairs and staircases.
9. Express the methods of white/color washing and paintings including distempering.
10. Explain various methods of shuttering, scaffolding and centering.
11. Locate the various types of expansion and construction joints and their construction.
12. Appraise the methods of sound and fire proof constructions as per I.S.standards.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Practical	2	30
Independent study	2	30
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-IV Term Test II: in 10th week, Unit V-VIII	2	15	25
1.2	Assignment I: in 6th week, Unit I-IV (Distinguish types and properties of building materials and explain the characteristics of concrete ingredient materials) Illustration: 1 Currency: 1	2	10	

	Clarity: 1 Originality: 1 Referencing: 1 Assignment II: in 11th week, Unit V-VII(Identify different construction details and indicates the various types of floors, their construction details, and selection criteria. Illustration: 1 Currency: 1 Clarity: 1 Originality: 1 Referencing: 1			
2	Continuous Assessment (Practical)			
2.1	Regular Assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).	1	15 1.5 4.5 3 3 3	25
2.2	Practical examination/Viva-Voce/Quiz.	1	10	
3	Semester End Examination: 3 hours, closed book.	1	50	50

Pre-requisites: None

Subject Matter:

Unit I: Building Stones and Bricks and Clay Products and Lime

1.1 Stones: Classification of rocks based on geological, physical and chemical composition, characteristics and use of various stones available in Bhutan – Stone quarrying methods, precautions to be taken, various explosives to be used – Methods of dressing and polishing of stones – Artificial stones – Various tests on stones as per I.S. Code.

1.2 Bricks: Sources and qualities of brick earth – Classification of bricks – Manufacture of bricks – Special forms of bricks and their uses – General qualities of bricks and their tests as per I.S. Code.

1.3 Clay Products: Various types of tile manufacturing and their uses, earthern wares, terra-cotta, stoneware, porcelain, glazing of tiles etc.

1.4 Lime: Classification of limes – Properties of lime – Preparation of lime including slaking of lime.

Unit II: Timber, Wood Based Products, Glass and Metals

2.1 Timber: Classification of timber – Properties of timber including testing methods – Seasoning and preservation of timber – Defects and decay – Properties of commonly available timber in Bhutan.

2.2 Wood Based Products: Veneers, plywood and its types – Manufacturing of plywood – Plywood grades as per I.S. Code – Laminated wood – Merits of plywood and laminated wood, laminated board, block board, batten board, hard board, particle board and composite board – Synthetic resins.

2.3 Glass: Ingredients and properties of glass – Types and selection of glass for different applications in the building industry.

2.4 Metals: Types of metals – Properties of iron, steel, aluminium – Non-ferrous alloys.

Unit III: Paints and Varnishes, Plastics, Asbestos and Bituminous Materials

3.1 Paints and Varnishes: Constituents and characteristics of paints – Types of paint and their uses – Constituents of varnishes – Uses of varnishes – Different kinds of varnish (Lacquer) and polishes etc.

3.2 Plastics: Chemical composition of plastics – Raw materials and manufacturing of plastics – Classification of various plastics and their applications.

3.3 Asbestos and Bituminous Materials: Availability and uses of asbestos – Properties of asbestos – Various types of asbestos – Difference between asphalt & bitumen – Types, uses, properties of asphalt and bitumen – Composition of coal tar, wood tar, mineral tar and Naphtha.

Unit IV: Cement and Concrete

4.1 Cement: Properties of Ordinary Portland Cement(OPC) – Manufacturing of OPC – Chemical composition of OPC – Types of cements and their applications – Laboratory and field tests on OPC as per IS standards – Storage of cement.

4.2 Concrete: Ingredients of concrete and their characteristics – Types of admixtures used in concrete, their functions and applications – Preparation of concrete: batching, mixing, transporting, placing, compaction and curing – Cold weather concreting - Properties of concrete and the relevant tests as per IS Codes – Concrete grades and mix designs as per IS code – Quality control measures in concrete preparation – Introduction to destructive and non-destructive tests.

Unit IV: Mortar

4.3 Mortars: Types and characteristics of mortar as per IS Code.
4.4 Damp proof materials: Types and characteristics of damp proof materials.

Unit V: Components of Building and Foundations

5.1 Elements of building and their functions.
5.2 Building bye laws and modular co-ordination.
5.3 Types of loads on buildings.
5.4 Types of foundations and their selection criteria.

Unit VI: Masonry and Walls:

6.1 Types of masonry: stone and brick masonry.
6.2 Plan, elevation, and sections of stone masonry.
6.3 Different types of brick bonds
6.4 Plan, elevation and section of brick bonds up to two brick wall thickness.
6.5 Types of walls and their design criteria and construction.
6.6 Solid walls, partition walls and cavity walls including damp proofing.

Unit VII: Floors & Plastering, Pointing and Painting

7.1 Types of floors and their selection criteria and construction.
7.2 Types of plastering and pointing and their selection criteria and construction.
7.3 White (Lime) washing and colour washing.
7.4 Painting and distempering.

Unit VIII: Roofs

8.1 Types of roofs and roof coverings.
8.2 Their selection criteria and construction including water proofing treatment.

Unit IX: Doors & Windows and Vertical Circulation

9.1 Types of doors and windows and their sizes – location and materials including construction.
9.2 Types of stairs and staircases.
9.3 Materials and proportion and their selection criteria.
9.4 Constructions including fire escape stairs – lifts and escalators.

Unit X: Joints and Form Works:

10.1 Types of joints: expansion and contraction, and their location and construction.
10.2 Centering and shuttering: their selection and construction.
10.3 Types of scaffolding – selection criteria and construction.

Unit XI: Sound and Fire Proof Construction:

11.1 I.S.Code specifications.
11.2 Selection criteria and construction of sound and fire proof constructions.

List of Practicals:

1. Preparation of brick and stone masonry of different types using sand as the mortar.
2. Determination of water absorption and dimensional tolerance of bricks.
3. Determination of compressive strength of bricks and timber with the help of UTM/ CTM.
4. Determination of fineness modulus and grading of fine and coarse aggregates.
5. Determination of moisture content and bulking of sand.
6. Determination of water content for standard consistency of cement and setting times of cement.
7. Determination of workability of concrete through slump and compaction factor tests.
8. Preparation of concrete specimens for characteristic strength tests and determination of their strengths.
9. Demonstration of the use of non-destructive test equipment.
10. Concrete Mix Design as per I.S. Code Method.

Reading Lists:

Essential Reading

1. Duggal, S.K. (2009). Building Materials. New Delhi: New Age International,
2. Punmia, B.C. (1997). Building Construction. New Delhi: Lakshmi Publications.
3. Technical Teachers' Training Institute, Chandigarh. (2006). Civil Engineering Materials. New Delhi: Tata-McGraw-Hill.
4. Rangwala, S.C. (2006). Building Materials (3 ed.). New Delhi: Charotar Publications.
5. Surendra, S. (1979). Engineering Materials. New Delhi: Konark Publishers.

Additional Reading

1. Arora, S.P. and Bindra, S.P. (1997). A Text Book of Building Construction. New Delhi: Dhanpat Rai Publications.
2. Kulkarni, C.J. (1968). A Text Book of Engineering Construction. Ahmedabad: Ahmedabad Book Depot.
3. Kumar, S. (1994). Engineering Construction. New Delhi: Standard Publishers & Distributers.
4. Jha, J., and Sinha, S.K. (2004). Building Construction. New Delhi: Khanna Publishers.
5. Kulkarni, C.J. (1974). A Text Book of Engineering Materials (9 ed.).Ahmedabad: Book Depot.
6. Shetty, M. S. (1994). Concrete Technology. New Delhi: New Age International Publishers.
7. Gambhir, M. L. (2002). Concrete Technology. New Delhi: TMH Publishers.
8. Varshney, R. S. (1982). Concrete Technology. New Delhi: Oxford and IBH Publishing Co.
9. Raina, V.K. (2004). Concrete for Construction: Facts and Practice (2 ed.). New Delhi: Shroff Publisher.

Date: Janaury 31, 2017

BE (Second Year) – Third Semester

Semester III				Contact Hours			Marks		
							Theory		Pract
#	Code	Module	Credit	L	T	P	CA	EX	CA
1	MAT204	Engineering Mathematics-III	12	4	1	0	30	70	0
2	FMH201	Fluid Mechanics	12	3	1	2	25	50	25
3	SUR201	Principles of Surveying-I	12	2	1	3	25	50	25
4	TSM102	Strength of Materials	12	3	1	2	25	50	25
5	BPD202	Building Drawing	12	2	0	3	50	50	0
Total				**14**	**4**	**10**	**155**	**270**	**75**
			60	**28**			**500**		

Module Code &Title : MAT204 Engineering Mathematics-III
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mr. V. Jayachandran

General Objective:
The module aims to provide students with the knowledge of mathematics of Complex Analysis which forms the background for much of the theoretical work in engineering. Students will be introduced to the structure of Laplace Transforms, Fourier Series, Linear Partial Differential Equations and their application in the field of engineering.

Learning Outcomes:

On completion of the module, students will be able to:

1. Find the conditions under which differentiation of functions of a complex variable is possible (Cauchy-Riemann conditions).
2. Use these conditions to the Laplace equation and to basic problems of flow.
3. Express complex functions as Laurent series about singular points and find residues of these functions to perform straightforward tasks of complex integration.
4. Evaluate real integrals using complex integration.
5. Apply the skill of computing integrals by means of residue calculus which is a major tool in integration and it is an invaluable tool in Physics, Engineering etc.
6. Solve Partial Differential Equations critically and efficiently using the appropriate methods.
7. Find the solution of Heat, Wave, Laplace equations of Polar and Cartesian Co-ordinates Systems.
8. Solve differential equations using Laplace Transform.
9. Apply the mathematical methods of Fourier Series to solve a wide range of problems in both Science and Engineering.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	4	60
Tutorial	1	15
Independent study/self-directed learning	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I Term Test II: in 10th week, Unit II	2	20	30
1.2	Tutorial Test: one test each after completion of every topic.	4	6	
1.3	Assignment I: in 7th week, Unit I (Express different functions in Fourier series). Assessment criteria Presentation(0 .5 Marks) Procedure (1.0 Marks) Final answer (0.5 Marks)	1	2	
1.4	Assignment II: in 13th week, Unit IV (Solve ordinary and simultaneous differential equation using Laplace Transform). Assessment criteria Presentation(0 .5 Marks) Procedure (1.0 Marks) Final answer (0.5 Marks)	1	2	
2	Semester End Examination: 3 hour,Closed book.	1	70	70

Pre-requisites: None

Subject Matter:

Unit I: Fourier Series

1.1 Introduction.
1.2 Euler's Formulae.
1.3 Fourier expansion conditions - Dirichlet. Function having a point of Discontinuity, Change of Interval, Odd and Even Functions. Half range series Expansion.

1.4 Typical waveforms Parsevals Identity, Complex or Exponential form of Fourier Series, Practical Harmonic Analysis.

1.5 Fourier series of Electrical waveforms – Saw Tooth, Rectangular, Sinusoidal, Square Wave.

Unit II:Complex Variables

2.1 Introduction.

2.2 Complex numbers: Definition, conjugate of a complex number. Properties of conjugates, modulus of a complex number. Geometrical representation of complex numbers.

2.3 Polar and circular form of complex numbers, Addition, subtraction, multiplication and division of complex numbers.

2.4 De Moiver's Theorem. Equation of a circle in complex plane.

2.5 Complex variable, Function of a complex variable f(z), continuity of a complex function. Derivative of f(z).

2.6 Cauchy-Riemann equations.

2.7 Analytic functions. Harmonic Functions orthogonal system- orthogonal system.

2.8 Geometrical representation of f(z).

2.9 Applications to flow and two dimensional potential problems.

2.10 Conformal transformation.

2.11 Some standard transformation.

2.12 Integration of complex function. Cauchy's theorem (simple problems) Cauchy's integral formula.

2.13 Series of complex functions. Taylor's series and Laurent's series, singular points-residues.

2.14 Calculus of Residues theorem, Contour integration-Evaluation of real definite integrals.

Unit III: Partial Differential Equations and Boundary Value Problems

3.1 Introduction.

3.2 Formation of Partial Differential Equations.

3.3 Solution of Standard Types Partial Differential Equations.

3.4 Equations solvable by Direct Integration.

3.5 Linear Equations of First Order.

3.6 Non-linear Equations of First Order. Char pit's Method.

3.7 Homogeneous Linear Equations with constant coefficients.

3.8 Rules of finding particular integral (P.I).

3.9 Working procedure to solve Homogeneous Linear Equations of any order.

3.10 Non-homogeneous Linear Equations.

3.11 Non-linear Equations of second order-mange's method.

3.12 Applications of Partial Differential Equations:

- 3.12.1 Classification of linear second order PDE.
- 3.12.2 Variable separable method.
- 3.12.3 Solution of Heat, Wave, Laplace equations – Polar and Cartesian Co-ordinate systems.

Unit IV: Laplace Transformations

4.1 Introduction: Definition.
4.2 Transforms of Elementary Functions.
4.3 Properties of Laplace Transforms.
4.4 Existence conditions. Inverse transforms.
4.5 Note on partial fraction. Transforms of Derivatives.
4.6 Transforms of Integrals. Multiplication by t n.
4.7 Division by 't'. Convolution Theorem.
4.8 Applications of Laplace Transforms to Differential Equations.
4.9 Simultaneous linear equations with constant coefficients.
4.10 Unit Step Functions, Unit Impulse Functions.
4.11 Periodic Functions. Special Functions.

Reading Lists:

Essential Reading

1. Spiegel, M.R. (1965). Theory and Problems of Laplace Transforms. Schaum's Outline Series, McGraw-Hill Book Company, Singapore.
2. Kreyszig, E. (2011). Advanced Engineering Mathematics (10 ed.). John Wiley & Sons (Asia) Pvt Ltd, Singapore.
3. Grewal, B.S. (2012). Higher Engineering Mathematics (42 ed.). Khanna Publishers, New Delhi.
4. Dass, H.K. (2013). Advanced Engineering Mathematics (21 ed.). S.Chand& Company Ltd, New Delhi.
5. Prasad, I.B. (1988). Practical Mathematics Vol I and Vol II (7 ed.). Khanna Publishers, New Delhi.

Additional Reading:

1. Jain, R.K. and Iyengar, S.R.K. (2014). Advanced Engineering Mathematics (4 ed.). Narosa Publishing house, New Delhi.
2. Rao, S.B. and Anuradha, H.R. (1996). Differential Equations with Application and Programmes (1 ed.). Universities Press (India) Ltd, Hyderabad.

Date: Febraury 4, 2017

Module Code & Title : FMH201 Fluid Mechanics
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mrs. Chimi Wangmo

General Objective:

This module aims to provide students with knowledge on fundamental laws and principles governing the behaviour of fluids at rest and in motion, including both laminar and turbulent flow through pipes. Students will also learn about methods of pressure and flow measurement. In addition, they will develop skills in performing laboratory experiments and learn how to analyse and interpret data.

Learning Outcomes:

On completion of the module, students will be able to:

1. Analyze fluid static and dynamic problems using conservation principles (mass, momentum, energy, Bernoulli).
2. Calculate the forces that act on submerged planes and curves.
3. Explain the working principles and application of various flow measuring devices
4. Identify flow types.
5. Apply the laws of fluid mechanics to turbulent flow through pipes and ducts.
6. Appraise the law of fluid dynamics and statics to laminar flow through pipes predict relevant pressures, velocities and forces.
7. Draw simple hydraulic and energy gradient lines.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Practical	2	30
Tutorial	1	15
Independent study	2	30
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.2	Term Test I: in 5th week, Unit I-V Term Test II: in 10th week, Unit VI – VII	2	20	25
1.3	Assignment I: in 6th week, Unit I-III (Dynamic problems using conservation principles (mass, momentum, energy, Bernoulli). Analysis of problem: 1.00 Using laws and theorem to formulate the mathematical equation:1.00 Mathematical calculation: 0.5 Assignment II: in 11th week, Unit VII-VIII (Appraise the law of fluid dynamics and statics to laminar flow through pipes predict relevant pressures, velocities and forces). Analysis of problem: 1.00 Using laws and theorem to formulate the mathematical equation:1.00 Mathematical calculation: 0.5	2	5	
2	Continuous Assessment (Practical)			

2.1	Regular Assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).	1	15 1.5 4.5 3 3 3	25
2.2	Practical Exam/Viva-voce/Quiz:		10	
3	Semester End Examination: 3 hours, closed book.	1	50	50

Pre-requisites: TSM101 Engineering Mechanics, MAT102 Engineering Mathematics II

Subject Matter:

Unit I: Introduction to Fluid Mechanics

1.1 Development of fluid mechanics.
1.2 Definition of fluid.
1.3 Basic Properties of fluid-Compressibility, Mass density, Specific weight, Specific volume, Specific gravity, Viscosity, Kinematic viscosity, Bulk modulus, Gas law, Vapour pressure, Surface tension, Capillarity.

Unit II: Pressure Measurement

2.1 Definition and forms of pressure.
2.2 Pascal's law.
2.3 Pressure variation with depth of liquid, absolute gauge and vacuum pressure.
2.4 Measurement of pressure: Manometers, open type and differential manometers, inverted differential manometers, micro manometers, Mercury barometer, and Aneroid barometer.

Unit III: Hydrostatics

3.1 Total pressure on: a horizontally immersed surface, vertically immersed surface & an inclined immersed surface.
3.2 Centre of pressure of a vertically immersed surface.
3.3 Pressure on curved surface.
3.4 Pressure due to one kind of liquid on one side, pressure due to one kind of liquid over another on one side.

3.5 Application of hydrostatics: Pressure diagrams, water pressure on rectangular masonry dams, water pressure on trapezoidal dams.

Unit IV: FluidKinematics

4.1 Hydro kinematics- Introduction, rate of discharge, Equation of continuity of liquid flow, Motion of fluid particles - Lagrangian and Eulerian methods.

4.2 Types of flow lines- path lines, Stream lines, steak lines or filament lines, potential lines or equipotential lines, flow net, uses of flow net.

4.3 Type of flow in a pipe- Uniform and Non-Uniform, Laminar & Turbulent flow, Steady & Unsteady flow, Compressible and incompressible flow, Rotational &Irrotational flow, One dimensional, Two-dimensional and Three-dimensional flow, Ideal fluids and real fluids.

Unit V: FluidDynamics

5.1 Introduction- Energy of liquid in motion.

5.2 Total energy or total head of liquid particle in motion, Bernoulli's equation, limitations of Bernoulli's equation.

5.3 Euler’s equations of motion, Impulse-Momentum equation, Momentum correction factor, Application and comparison of momentum equation and energy equation.

Unit VI: Flow Measurement

6.1 Basic Principles and working of aVenturimeter, Orifice-meter, Pitot tube, and bend meter.

6.2 Discharge through sharp edge circular orifice, small rectangular orifice and large rectangular orifice, discharge through a drowned orifice under pressure, time of flow of liquid from one vessel to another.

6.3 Flow through mouth pieces- external mouthpiece, internal mouthpiece-running free and running full.

6.4 Flow through nozzle.

6.5 Flow over notches - types, discharge over rectangular notch and triangular notch, advantage of triangular notch over rectangular notch, Discharge over trapezoidal notch.

6.6 Flow over weirs-types, discharge over a rectangular weir, Francis formula and Bazin formula, Cippoletti weir, Discharge over a narrow crested weir, broad crested weir, sharp crested weir, Ogee weir and drowned weir.

Unit VII: Flow through Pipes

7.1 Reynolds's experiment on flow through pipes.

7.2 Darcy-Weisbach equation.

7.3 Wetted parameter, area of flow, hydraulic radius.

7.4 Empirical formula-Chezy's formula, Manning's formula, Hazen-William's formula, Gangvillet-Kutter’s formula.

7.5 Energy losses in Pipes: Major& Minor losses.

7.6 Pipe discharging from a reservoir, Pipe connecting two reservoirs, Pipes in series, Pipes in parallel, Flow through a bye-pass pipe, Siphons, Pipes connecting three reservoirs, Branch mains, Loss of head in a pipe with varying discharge in non-circular conduits, transmission of power, Water Hammer,

Horse power, water hammer when valve is gradually closed and when the valve is suddenly closed.

Unit VIII: Laminar Flow in Pipes

8.1 Relationships between shear stress and pressure-gradient.
8.2 Hagen-Poiseuille law.
8.3 Laminar flow thorough inclined pipes.
8.4 Flow through porous media, concentric cylinder, Measurement of viscosity.

Unit IX: Turbulent Flow in Pipes

9.1 General expression for shear stresses.
9.2 Boundary layer in pipes, (laminar and turbulent flow).
9.3 Hydro-dynamically smooth and rough pipes.
9.4 Velocity distribution-equation for smooth and rough pipes.

List of Practical:

1. Verification of Bernoulli's theorem.
2. Determination of coefficient of discharge of Venturimeter.
3. Determination of coefficient of discharge of triangular, rectangular and trapezoidal notches.
4. Determination of coefficients of discharge and coefficient of velocity through orifice.
5. To study flow net by Hele-Shaw apparatus.
6. To find losses in a piping systems and loss factors in a piping system.

Reading Lists:

Essential Reading

1. Modi, P.N. and Seth, S.M. (1973). Hydraulics and Fluid Mechanics (14 ed.). New Delhi: Standard Book House.
2. Bansal, R. K., (2005). A Textbook of Fluid Mechanics and Hydraulics Machines (3 ed.). New Delhi: Laxmi Publications.
3. Jain, A.K. (1998). A Text Book of Fluid Mechanics (9 ed.). New Delhi: Khanna Publishers.
4. Lal Jagdish. (2002). Fluid Mechanics & Hydraulics (9 ed.), New Delhi: Metropolitan Book Co.

Additional Reading

1. Giles, Ranald V. (2006). Schaum's Outline of Theory and Problems of Fluid Mechanics and Hydraulics (2 ed.). New Delhi: Tata McGraw Hill.
2. Gupta, V.P, Sing Alam and Gupta Manish. (2004). Fluid Mechanics, Fluid Machines and Hydraulics(2 ed.). New Delhi: CBS.
3. Asawa, G.L. (1987). Experimental Fluid MechanicsVolume 1 (3 ed.). Roorkee: Nem Chand & Bros.
4. Garde, R.J and GaokerMiraj. (1983). Engineering Fluid Mechanics (2 ed.). New Delhi: Nem Chand & Sons.

5. Rajput, R.K. (2002). Fluid Mechanics and Hydraulic Machines (2 ed.). New Delhi: S Chand & Company.
6. Rajput RK. (2002). Fluid Mechanics& Hydraulic Machines (2 ed.). New Delhi: S Chand & Company.
7. K.Subramanya. (2001). Theory and Application of Fluid Mechanics (2 ed.). New Delhi: Tata-Mc Graw Hill.
8. Garde, R.J and GaokerMiraj. (1983). Engineering Fluid Mechanics (including Hydraulic Machine) (2 ed.). Roorkee: Nem Chand & Bros.
9. Kumar, K L. (1976). Engineering Fluid Mechanics (1 ed.). New Delhi: Eurasia Publishing House.
10. Gupta, Vijay.,& Gupta, S.K. (2000). Fluid Mechanics & Its Application (3 ed.). New Delhi: New age International.
11. Streeter, V.L. (1983). Fluid Mechanics (1 ed.). New Delhi: Tata-McGraw Hill Company.
12. Besavilla, Venancio I. (1986). Fluid Mechanics/Hydraulics (2 ed.). New Delhi: VB Publisher.
13. Arora, K.R. (1980). Fluid Mechanics Hydraulics and Hydraulic Machines (2 ed.). New Delhi: Standard Publishers Distributors.
14. Lal, Jagdish. (2002). Fluid Mechanics and Hydraulics/Computer applications (2 ed.). New Delhi: Metropolitan Book.
15. Govida Rao, N. S. (1976). Mechanics of Fluid (2 ed.). New Delhi: Orient Longman.
16. Narayana Pillai and C R Ramakrishna. (1999). Principles of Fluid Mechanics and Fluid Machines (2 ed.). New Delhi: Universities Press.
17. Vennard, J.K. (2001). Elementary Fluid Mechanics (3 ed.). New Delhi: John Wiley.
18. Likhi, S. K. (2001). Hydraulics Lab Manual.

Date: Janaury 31, 2017

Module Code & Title : **SUR201 Principles of Surveying-I**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Dr. Cheki Dorji, Namgay OM and Mr. Leki Dorji**
Module Coordinator : **Mr. Leki Dorji**

General Objective:
The module aims to introduce the principles of surveying and applications of linear and angular measuring instruments. Students will also be exposed to various surveying instruments and methods of surveying. Through this module, students will acquire basic surveying skills, develop the ability to prepare maps to any scale and compute data for surveying.

Learning Outcomes:

On completion of the module, students will be able to:
1. Exhibit the basic surveying skills.
2. Identify various surveying instruments.
3. Perform different methods of surveying.
4. Perform the basic methods of leveling.
5. Compute data required for surveying.

6. Distinguish the surveying maps from the normal maps.
7. Determine the elevation using different methods

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	2	30
Practical	3	45
Tutorial	1	15
Written assignment	1	15
Independent study	1	15
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I- III Term Test II: in 10th week, Unit IV-VII	2	20	25
1.2	Assignment I: in 6th week, Unit I-II (Recognize the various types of Instrument in Surveying and exhibit basic method of surveying). • Introduction/Neat drawing • Methods/steps/procedure • Conclusion Assignment II: in 11th week, Unit III-V (Compute the data required for Surveying and differentiate the survey maps from normal maps). • Introduction/Neat Tabulation • Methods/steps/procedure • Conclusion	2	0.5 1.5 0.5 0.5 1.5 0.5	
2	Practical			
2.1	Regular assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about	1	15 1.5 4.5 3 3 3	25

	the data). • Conclusion (state what student has learned by doing the experiment).			
2.2	Practical Examination/Viva-voce/Quiz:		10	
3	Semester End Examination: 3 hours, closed book.	1	50	50

Pre-requisites: MAT201 Engineering Mathematics – II, EGP101 Engineering Graphics

Subject Matter:

Unit I: Introduction

1.1 Importance of surveying, classification of surveys.
1.2 Stages of survey operations.
1.3 Principle of surveying, conventional signs.
1.4 Surveying instruments, their care and adjustment.

Unit II: Measurement of Distances

2.1 Principle of different methods and their accuracies.
2.2 Measurement by tape, sources of errors and precautions.
2.3 Corrections to tape measurements.

Unit III: Measurement of Angles and Directions

3.1 Reference meridians, bearing and azimuths, magnetic declination and its variations.
3.2 Use and temporary adjustments of compass, theodolites.
3.3 Measurement of horizontal and vertical angles by theodolites.

Unit IV: Traversing

4.1 Principles of traversing by compass and theodolite.
4.2 Field work and checks, computation of coordinates by using Gale's traverse table.
4.3 Sources of errors, precision of traversing, checking and adjusting of traverses, omitted measurements.

Unit V: Measurement of Elevations

5.1 Different methods of determining elevations-leveling.
5.2 Trigonometric, Tachometry, definitions of terms, principle.
5.3 Temporary and permanent adjustments of levels, methods of booking and reduction of field notes.
5.4 Introduction to curvature and refraction corrections, reciprocal leveling.
5.5 Plotting of profiles, reciprocal observations, sources of errors and precision of leveling procedures.

Unit VI: Plane Table Surveys

6.1 Principles, advantages and disadvantages, plane table equipment.

6.2 Methods of plane table surveying, Resection-two and three point problems, field work in plane table surveying.

List of Practicals:

1. Determination of horizontal distance along a sloping ground by linear measurements
2. Observe and determine bearings of traverse by compass.
3. Plot traverse and correct traverse by plane table.
4. Determination of reduction levels of given points using leveling instruments by both heights on instrument and rise and fall methods.
5. Establish a benchmark by check leveling.
6. Draw the longitudinal and cross sections profiles along a given route.
7. Take horizontal and vertical angular measurements repetition and reiteration method.
8. Determination of the tachometric constants of a given theodolite and gradient between two points.
9. Perform traversing by tachometric method.
10. Determination of elevations of a given point by trigonometrical levelling.

Reading Lists:

Essential Reading

1. Agor, R. (2000). Surveying Volume I (3 ed.). New Delhi: Khanna Publications.
2. Agor, R. (2000). Surveying Volume II (3 ed.). New Delhi: Khanna Publications.
3. Duggal, S. K. (2007). Surveying –I (2 ed.). New Delhi: Tata Mcgraw Hill.
4. Duggal, S. K. (2007). Surveying –II (2 ed.). New Delhi: Tata Mcgraw Hill.
5. Chandra, A.M. (2005). Surveying –I (2 ed.). New Delhi: New Age International.

Additional Reading

1. Pumia, B.C. (2000). Surveying –I (3 ed.). New Delhi: Laxmi Publications.
2. Pumia, B.C. (2000). Surveying –II (3 ed.). New Delhi: Laxmi Publications.
3. Rangwala, S.C. (2005). Surveying and Leveling (2 ed.). New Delhi: Charotar Publishing House.
4. Husain, S.K. (1985). Textbook of Surveying (1 ed.). New Delhi: Oxford & IBH Publishing Co.
5. Arthur, B., & Stanley, R. (2006). Surveying (2 ed.). New Delhi: Prentice-Hall.

Date: Janaury 31, 2017

Module Code & Title : **TSM102 Strength of Materials**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr.Tshewang Nidup, Mrs. Monika Thapa and Ms. Lily Gurung**
Module Coordinator : **Mr.Tshewang Nidup**

General Objective:

The module aims to provide the fundamental concepts of analyzing various structural members and systems used in engineering application by introducing the mechanism of the behaviors and responses of key structural elements like beams, columns, trusses, shells, vessels and thin cylinders subjected to different loading conditions

Learning Outcomes:

On completion of the module, students will be able to:

1. Explain the mechanical and engineering properties of engineering materials.
2. Draw shear force and bending moment diagram with different loads and support conditions.
3. Determine bending stresses, shear stresses and shear centre.
4. Compute principal stresses, strains and direction of planes.
5. Design shafts.
6. Analyze forces in truss members by different methods.
7. Compute buckling load by Rankine and Euler's approach for compression members.
8. Compute slope and deflection of beams by double integration method, moment area method, conjugate beam method, Macaulay's method.
9. Design thin cylindrical and spherical shells.
10. Analyze fixed and continuous beam using Clapeyron's Theorem.
11. Conduct relevant tests on materials.
12. Analyse data from the material tests.

Learning and Teaching Approach:

Approach	Hours per Week	Total Cred Hours
Lecture	3	45
Tutorial	1	15
Practical	2	30
Independent study/self-directed learning	2	30
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VIII	2	20	25
1.2	Assignment I: in 6th week, Unit I-III (Draw shear force and bending moment diagram with different loads and support conditions, and determine bending and shearing stresses). - Use of appropriate formula: 0.25 - Diagram with clear labels: 0.50 - Correct Calculations: 0.75 - Final answer and diagrams labelled	2	5	

	with units: 1.00 Assignment II: in 12th week, Unit IV-VIII (Analyse trusses, design thin shells, compute buckling loads for compression members, and determine slope and deflection for beams). - Use of appropriate design method: 0.25 - Diagram with clear labels: 0.50 - Correct Calculations: 0.75 - Final answer and diagrams labelled with units: 1.00			
2	Continuous Assessment (Practical)			
2.1	Regular assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).	1	15 1.5 4.5 3 3 3	25
2.2	Practical examination/Viva Voce/Quiz:		10	
3	Semester End Examination: 3hours, closed book.	1	50	50

Pre-requisites: TSM101 Engineering Mechanics

Subject Matter:

Unit I: Simple Stresses and Strain

1.1 Elastic and plastic behavior of engineering materials and mechanical properties.
1.2 Analysis of simple stresses and strains.
1.3 Elastic constants, thermal stresses and complimentary shear stresses and strains, strain energy.

Unit II: Bending Moment and Shear Force

2.1 Bending moment and shear force of beams with different support conditions and with different loads such as point load, uniformly distributed load, moment, varying loads and their combinations.

Unit III: Bending Stress and Shearing Stress:

3.1 Bending and shearing stresses in beams- symmetrical and unsymmetrical section, solid and thin walled sections.

Unit IV: Torsion

4.1 Torsion in solid and hollow shaft.
4.2 Design of shaft.

Unit V: Compound Stresses:

5.1 Principle plane and principle stresses.
5.2 Mohr's circle, principal strain.

Unit VI: Combined Stresses

6.1 Beams subjected to bending and shear.
6.2 Shafts subjected to bending and torsion.
6.3 Short columns.

Unit VII: Analysis of Truss

7.1. Analysis of Truss by method of section, method of joints and graphical method.

Unit VIII: Slope and Deflection of Beams:

8.1. Slope and deflection of beams by double integration method, moment area method, conjugate beam method, Macaulay's method.

Unit IX: Column and Strut:

9.1 Buckling of struts, eccentrically and axially loaded columns.
9.2 Analysis of columns and strut using Rankine's and Euler's approach.

Unit X: Thin Cylindrical and Spherical Shells

10.1 Thin cylindrical and spherical shells and internal pressure.
10.2 Change in volume of cylindrical shells.

Unit XI: Fixed and Continuous Beams:

11.1. Clapeyron's Theorem of three moments, EI constant.

List of Practicals:

1. Introduction to testing equipments.
2. Uniaxial tension test (Mild steel and Timber, Wires).

3. Uniaxial compression test (Timber, Bricks, Concrete, etc.).
4. Torsion Test (Mild steel and Aluminum).
5. Bending stress distribution in beams using Extensometer.
6. Analysis of truss model with spring member.
7. Behavior of Strut and Columns.
8. Impact Resistance - Charpy and Izod Tests.
9. Brinnell's Hardness Test.

Reading Lists:

Essential Reading

1. Popov, E.P. (2005). Engineering Mechanics of Solids. New Delhi: Prentice Hall of India.
2. Rajput, E.R.K. (2010). Strength of Materials (5 ed.). New Delhi: S. Chand & Co.
3. Ramamrutham, S. (2009). Strength of Materials (2 ed.). New Delhi: Dhanpat Rai.
4. Nash. W. A. (2007). Strength of Materials(2 ed.).New Delhi: Tata McGraw Hill.
5. Prasad, I. B. (2006). A Text Book of Strength of Materials (2 ed.). New New Delhi: Khanna Publishers.

Additional Reading

1. Negi, L.S. (2008). Strength of Materials (3 ed.). New Delhi: Tata McGraw Hill.
2. Timoshenko. S. (2004). Strength of Materials (2 ed.). New Delhi: CBS.
3. Sarkar, B.K. (2008). Strength of Materials (3 ed.). New Delhi: Tata McGraw Hill.
4. Sood. H. (2007). Laboratory Manual on Testing of Engineering Materials (1 ed.). New Delhi: New Age International.

Date: Janaury 31, 2017

Module Code & Title : BPD202 Building Drawing
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mrs. Tshering Cheki

General Objective:

This module will familiarise students with the different aspects of building drawing, the knowledge of which will enable them to plan and draw different components of a building. Students will develop the skills to produce building drawings manually and by using drafting software. Besides, the module will also expose students to the components of traditional Bhutanese architecture.

Learning Outcomes:

On completion of the module, students will be able to:

1. Draw various components of building – Masonry, Doors and Windows, Roofs and Staircases.
2. Draw the building plan, elevations and sections incorporating traditional architectural elements of Bhutan.
3. Produce a Building drawing manually and with drafting software.
4. Develop the planning aspects and principles for residential buildings.

5. Identify the different types of building materials, plumbing and sanitary accessories and fittings.
6. Plan healthy sanitation and effective plumbing network system.
7. Interpret building bye laws, standards and rules and regulations.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	2	30
Practical	3	45
Independent study/self-directed learning	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VI (Term test covers theory, design and drawing)	2	30	50
1.2	Assignment I: in 6th week, Unit I-III (Draw various components of building manually with proper dimensions). Pencil work:1 Proportioning or scale:1 Correctness:3 Assignment II: in 11th week, Unit IV-VI (Design and draw building components incorporating the traditional Architectural elements of Bhutan manually with proper dimensioning). Pencil work:1 Proportioning or scale:1 Correctness:3	2	10	
1.3	Project Work: in 12th week, Unit VIII (Design and Draw building with the help of drafting software to a suitable scale, the plans, elevations, sections and other details incorporating all the building components and elements of traditional Bhutanese Architecture covered in the class). Assessment Criteria of (Report) • Standard title block.	1	10 1	

	• Drawing neatness and accuracy. • Completeness (Plans, elevations, sections and detailing) • Materials and symbols properly used.[1] • Proper dimensioning and labelling.		1 5 1 2	
2	Semester End Examination: 4 hours, closed book manual drawing.	1	50	50

Pre-requisites: EGP101 Engineering Graphics, BPD101 Building Materials and Construction

Subject Matter:

Unit I: Masonry

1.1 Different type of brick and stone masonry.
1.2 Different types of bricks bonding.

Unit II: Traditional Architecture

2.1 Elements of Bhutanese architecture (Chimthog/Roof and Thogcha/Truss, Rabsel/Bay window, Payab and Mago/Window and Door, Kachen and Zhu/Columns and Brackets, Traditional Railings and Cornices for different floor levels).
2.2 History of Bhutanese architecture.

Unit III: Door and Windows

3.1 Identify the components and draw the details of: Doors and Windows (Both in terms of conventional and traditional Bhutanese architecture).

Unit IV: Staircase

4.1 Identify the components and different types of staircase.
4.2 Draw the details of a traditional stair case: Dog legged type and Open well type.

Unit V: Roof Truss

5.1 Identify and draw various components of a King post roof truss.
5.2 Draw the details of a traditional Bhutanese timber roof truss.
5.3 Draw the details of a steel tubular roof truss with connection details.

Unit VI: Plumbing and Accessories

6.1 Identify the various components of septic tank and soak pit.
6.2 Draw plan and section of a septic tank.
6.3 Draw plan and section of a soak pit connected to the above septic tank.
6.4 Sketch inspection chamber, gully trap, floor trap, p-trap, q- trap, s-trap and w.c (Squatting and English type) and soil pipe connections.

Unit VII: Building Drawing

7.1 Building bye-laws and types of buildings,
7.2 Principles of building planning and Principles of building lighting.
7.3 Draw the details (Plan, sectional elevation, elevations and foundation details) for the following:
  7.3.1 Single storied (Bungalow) building incorporating traditional Bhutanese architecture.
  7.3.2 Two storied (Duplex) building incorporating traditional Bhutanese architecture.

Unit VIII: Project:

8.1 Planning, Designing and Drawing of multi storied building with the help of drafting software to a suitable scale, the plan, elevations sections and other details incorporating traditional Bhutanese Architecture.
8.2 Special consideration for space utilization, circulation, parking and aesthetical planning.

Reading Lists:

Essential Reading

1. Bhatt, N.D. (2006). Elementary Engineering Drawing (16 ed.).New Delhi: Charotar Publications.
2. Bhatt, N.D., and Panchal, V.M. (2002). Engineering Drawing- Plain and solid Geometry (17 ed.). New Delhi: Charotar Publications.
3. Chakraborti,M.(2001).Civil Engineering Drawing- including Architectural aspects (5 ed).
4. Sikka, V.B. (2004). A Course in Civil Engineering Drawing. New Delhi.
5. Ministry of works and Human Settlement “Bhutanese Architecture Guidelines”(2014).

Additional Reading

1. Swamy, N. K., and Kameswara, R.A. (2007). Building Planning and Drawing (16 ed.). New Delhi: Charotar Publishing House.
2. SP:7(1)-1983. National Building Code of India 2005. New Delhi: Bureau of Indian standards.
3. DUDH. (2002). Bhutan Building Rules 2002. Thimphu: DUDH, MoWHS.

Date: Janaury 31, 2017

BE (Second Year) – Fourth Semester

Semester IV				Contact Hours			Marks		
							Theory		Pract
#	Code	Module	Credit	L	T	P	CA	EX	CA
1	MAT207	Engineering Mathematics-IV	12	4	1	0	30	70	0
2	FMH202	Hydraulics	12	3	1	2	25	50	25

3	SUR202	Principles of Surveying-II	12	2	1	3	25	50	25
4	FED201	Engineering Geology	12	2	0	2	25	50	25
5	TSM203	Structural Mechanics-I	12	3	1	0	30	70	0
Total				**14**	**4**	**7**	**135**	**290**	**75**
			60	**25**			**500**		

Module Code & Title : MAT207 Engineering Mathematics-IV
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mr. V Jayachandran
Module Coordinator :

General Objective:

The module aims to introduce students to the mathematical techniques required for solving engineering problems using Fourier Transforms and Special Functions. The module also intends to equip students with the essential concepts of Linear Algebra via the theory of Vector Spaces and Linear Transformations. In addition, students will also acquire basic knowledge of Probability Theory and Statistical Concepts.

Learning Outcomes:

On completion of the module, students will be able to:

1. Explain a variety of special functions and their use.
2. Use the compact form most of the properties of Legendre's polynomials in the simplest possible way.
3. Evaluate definite integrals using the Beta and Gamma function.
4. Solve the ODE by Power series and Frobenius Method.
5. Find the solution of differential equations in terms of Bessel functions.
6. Write polynomials in terms of Legendre's polynomials.
7. Apply Probability theory and Statistical concepts, by means of essential definitions and standard distributions.
8. Apply the basic working knowledge of Mathematical methods in Fourier Transform in engineering problems.
9. Use Orthogonal Basis to solve Gram – Schmidt process.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	4	60
Tutorial	1	15
Independent study/self-directed learning	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			

1.1	Term Test I: in 5th week, Unit I Term Test II: in 10th week, Unit II	2	20	30
1.2	Tutorial Test: Closed Book, One test each after completion of every topic.	4	6	
1.3	Assignment I: in 7th week, Unit II (Express the function in Fourier integrals and finding Fourier transform of different functions using appropriate properties). Assessment criteria Presentation(0 .5 Marks) Procedure (1.0 Marks) Final answer (0.5 Marks)	1	2	
1.4	Assignment II: in 13th week, Unit III (Evaluate the correlation coefficient between two variables and find the probability using appropriate distributions). Assessment criteria Presentation(0 .5 Marks) Procedure (1.0 Marks) Final answer (0.5 Marks)	1	2	
2	Semester End Examination: 3 hours, Closed book.	1	70	70

Pre-requisites: None

Subject Matter:

Unit I: Special functions series solution of differential equations

1.1. Introduction
1.2. Series solution validity of series solution.
1.3. Power Series Method and Frobenius method for solving Ordinary differential Equations
1.4. Bessel Equation
1.5. Bessel's function[Jn(x)], Recurrence Formula for Jn(x).
1.6. Expansion for Jo and J1-values of J1/2.
1.7. Generating Function for Jn(x).
1.8. Equations reducible to Bessel's Equation.
1.9. Orthogonality of Bessel Functions.
1.10. Fourier Bessel expansion of f(x),.
1.11. Legendre's equation.
1.12. Legendre's polynomial[Pn(x)], Rodriguez's Formula Legendre's Polynomials.
1.13. Generating Function for Pn(x).
1.14. Orthogonality of Legendre's Polynomials, Fourier-Legendre expansion of f(x).
1.15. Other Special Functions Laguerre's Polynomials. Chebyshev. Polynomials.

1.16. Beta and Gamma functions.

Unit II: Fourier Transforms

2.1 Introduction,Definition of Integral Transforms. (Laplace, Fourier, Mellin transforms).
2.2 Fourier Integral Theorem.
2.3 Fourier Sine and Cosine Integrals.
2.4 Complex forms of Fourier Integrals.
2.5 Fourier Integral representation of a function.
2.6 Fourier Transforms. Fourier Sine and Cosine Transforms.
2.7 Finite Fourier Sine and Cosine Transforms.
2.8 Properties of Fourier Transforms Convolution Theorem.
2.9 Parseval's Identity.
2.10 Relation between Fourier and Laplace Transforms. Fourier Transforms of derivatives of a function.

Unit III: Statistics and Probability

3.1 Measures of central tendency
3.2 Measures of Dispersion
3.3 Correlation(including Rank correlation) and regression
3.4 Sample Spaces
3.5 Axioms of Probability
3.6 Conditional Probability
3.7 Standard Distributions and z-Distribution
3.8 Joint Probability Distributions
3.9 Sampling Distributions
3.10 Point and Interval Estimation

Unit IV: Linear Algebra

4.1 Groups
4.2 Rings
4.3 Fields
4.4 Vector Space
4.5 Basis and Dimension
4.6 Linear Transformation
4.7 Change of Basis
4.8 Inner Product Space
4.9 Orthogonal Basis
4.10 Gram – Schmidt process

Reading Lists:

Essential Reading

1. Kreyszig, E. (2011). Advanced Engineering Mathematics (10 ed.). Singapore: John Wiley & Sons (Asia) Pvt Ltd.

2. Grewal, B.S. (2007). Higher Engineering Mathematics (40 ed.). New Delhi: Khanna Publishers.
3. Dass, H.K. (2013). Advanced Engineering Mathematics (21 ed.). New Delhi: S.Chand& Company Ltd.
4. Jain, R.K., and Iyengar S.R.K. (2002). Advanced Engineering Mathematics. New Delhi: New Age International.
5. Rao, B. S., and Anuradha, H.R. (2008). Differential Equations with Application and Programmes. New Delhi: S. Chand & Company.

Additional Reading

1. Miller, and John, E. F. (2016). Probability & Statistics for Engineers (9 ed). New Delhi: Prentice Hall of India.
2. Iyengar, T.K.V. and Gandhi, B.K. (2010). Probability & Statistics. New Delhi: S.Chand& Company.
3. Singh, S. (2011). Linear Algebra. New Delhi: Vikash Publishing House Pvt Ltd.

Date: Febraury 4, 2017

Module Code &Title : **FMH202 Hydraulics**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Kirtan Adhikari and Mr. Leki Dorji**
Module Coordinator : **Mr. Leki Dorji**

General Objective:
The objective of this module is to provide students with an understanding of hydraulics as applied to environmental civil engineering works. It also aims to provide students with an understanding of the working principles of various types of hydraulic machines.

Learning Outcomes:

On completion of the module, students will be able to:
1. Solve uniform open channel flow problems.
2. Identify flow types in open channel flow.
3. Apply dimensional analysis and similitude in order to account for the implications of scale in model experiment.
4. Calculate depth profiles in channels with steady and unsteady gradually-varied flow.
5. Determine the impact of jets various plates.
6. Explain the working principles of hydraulic turbines.
7. Identify various types of pumps.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Practical	2	30
Tutorial	1	15
Written assignment	1	15
Independent study	1	15
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week Unit IV-VI	2	20	25
1.2	Assignment I: in 6th week, Unit I-II (Solve the problem based on uniform flow and identify the flow types in open channel). • Correct Formula • Steps written • Result Assignment II: in 11th week, Unit III-IV (Calculate depth profiles in channels with steady and unsteady gradually-varied flow and solve pproblems solving on impact of jets on various plates). • Correct Formula • Steps written • Result	2	0.5 1.5 0.5 0.5 1.5 0.5	
2	Continuos Assessment (Practical)			
2.1	Regular assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has	1	15 1.5 4.5 3 3 3	25

	learned by doing the experiment).			
2.2	Practical examination/Viva-voce/Quiz		10	
3	Semester End Examination: 3hours, closed book.	1	50	50

Pre-requisites: TSM101 Engineering Mechanics, FMH201 Fluid Mechanics

Subject Matter:

Unit I: Flow in Uniform Open Channels

1.1 Types of flow in channel Geometric properties of a channel section.
1.2 Velocity distribution – Uniform flow.
1.3 Ganguillent-Kutter Formula, Bazin's formula, Chezy's formula and Manning's formula.
1.4 Most economical section of channel: rectangular, trapezoidal, triangular and circular channel sections.
1.5 Computation of uniform flow, Specific energy and critical depth, Momentum in open channel flow.
1.6 Specific force, Critical flow and its computation, Application of specific energy and discharge diagrams to channel transitions.
1.7 Mean velocity of flow in channels, Measurement of discharge in rivers.

Unit II: Non-Uniform flow in Open Channels

2.1 Gradually varied flow, Classification of channel bottom profiles and surface profile
2.2 Characteristics of surface profiles, Hydraulic jump in rectangular channels.
2.3 Types of hydraulic jump and its location, Simple waves and Surges in open channels.

Unit III: Dimensional Analysis, Hydraulic Similitude, and Model Investigation

3.1 Dimensions, Dimensional homogeneity, Raleigh and Buckingham's π theorems, applications.
3.2 Model investigation Similitude, Geometric, kinematics and dynamic similarities.
3.3 Dimensionless numbers, Model Laws, Types of models, Merits and limitations of distorted models.
3.4 Scale effect, Application of dynamic similarity in model investigations.

Unit IV: Impact of Free Jets

4.1 Force exerted by fluid jet on stationary flat plate.
4.2 moving plate, stationary curved vane and moving curved vane –
4.3 Angular Momentum Principle.
4.4 Torque exerted on a wheel with radial curved vanes.

Unit V: Hydraulic Turbines

5.1 Elements of Hydroelectric turbines, Head and efficiencies of hydraulic power plants.

5.2 Classification of turbines, Pelton wheel.
5.3 Work done and efficiency, Construction details of Pelton turbine runner, multiple jet Pelton wheel.
5.4 Reaction turbines, Francis turbine, Work done and efficiency, Construction details of runner.
5.5 Draft Tube Theory, Kaplan turbine, governing of turbines, Runaway speed, Surge tanks.
5.6 Performance of turbines, Performance under unit head, Unit quantities.
5.7 Performance under specific conditions, Specific speed, Performance characteristic curves.
5.8 Model testing of turbines – Cavitation – Selection of turbines.

Unit VI: Hydraulic Turbines:

6.1 Main components and working principle, Different types.
6.2 Work done by a single-acting pump and double-acting pump.
6.3 Coefficient of discharge – Percentage of slip – Negative slip
6.4 Effect of acceleration of piston on velocity and pressure in the suction and delivery pipes Indicator diagrams – Air vessels – Multi-cylinder pumps.

Unit VII: Centrifugal Pumps
7.1. Components and working – Different types – Work done by the impeller.
7.2. Head, losses and efficiencies – Minimum starting speed – Specific speed - Model testing of pumps – Multi-stage pumps – Pumps in parallel – Performance of pumps.
7.3. Characteristic curves – Limitation of suction lift – Cavitation – Priming devices – Centrifugal pumps troubles and remedies.

List of Practicals:

1. Calibration of the given notches.
2. Study of flow in a rectangular channel with a hump in the bottom.
3. Study of submerged hydraulic jump below a spillway.
4. Study of impact of jets.
5. Determination of Manning's constant.
6. Determination of characteristic curves for a hydraulic ram.
7. Determination of characteristic curves and specific speed of a Pelton wheel.
8. Determination of characteristic curves and specific speed of a Francis turbine.

Reading Lists:

Essential Reading

1. Modi, P.N. and Seth, S.M. (2000). Hydraulics and Fluid Mechanics including Hydraulic Machines (14 ed.). New Delhi: Standard Book House.
2. Bansal, R.K. (2008). A Text Book of Fluid Mechanics and Hydraulic Machines. New Delhi: Laxmi Publication.
3. Jain, A.K. (2007). A Text Book of Fluid Mechanics (9 ed.). New Delhi: Khanna Publishers.
4. Jagdish, L. (2002). Fluid Mechanics & Hydraulics (9 ed.). New Delhi: Metropolitan Book Co.

Additional Reading

1. Garde and Raju, R. (2001). Flow through Open Channel. New Delhi: Universities Press.
2. Chow, V.T. (1973). Open Channel Hydraulics. Singapore: McGraw Hill.
3. Subramanya, K. (2006). Flow in Open Channel (2 ed.). New Delhi: McGraw Hill.
4. Subramanya, K. (2004). Theory and Application of Fluid Mechanics. New Delhi: Tata McGraw Hill.
5. Likhi, S. K., (2001). Hydraulics Lab Manual.
6. Narayana, P. and Ramakrishna, C. R. (2006). Principles of Fluid Mechanics and Fluid Machines (2 ed.). New Delhi: Universities Press.
7. Lewitt, E.H. (2005). Hydraulics and Mechanics of Fluid. New Delhi: Pitman.
8. Streeter, V.L. (1983). Fluid Mechanics (1 ed.). New Delhi: McGraw Hill.
9. Vennard, J.K. (2004). Elementary Fluid Mechanics. New Delhi: John Wiley.
10. Garde, R.J., and Gaoker, M. (1983). Engineering Fluid Mechanics including Hydraulic Machine (2 ed.). Roorkee: Nem Chand & Bros.
11. Rajput, R.K. (2002). Fluid Mechanics & Hydraulic Machines (2 ed.). New Delhi: S Chand &Company.
12. Ramadurgaiah, D. (2001). Fluid Mechanics and Machinery. New Delhi: New Age International.
13. Rouse, H. (2004). Elementary Mechanics of Fluids. New Delhi: John Wiley & Sons.
14. Kumar, K. L. (1976). Engineering Fluid Mechanics (1 ed.). New Delhi: Eurasia Publishing House.
15. Govida Rao, N. S. (1976). Mechanics of Fluid. New Delhi: Orient Longman.
16. Gupta, V., and Gupta, S. K. (2006). Fluid Mechanics & its Application. New Delhi: New Age International.
17. Davis, C.V. (1998). Hand Book of Applied Hydraulics. New Delhi: McGraw Hill.

Date: Janaury 31, 2017

Module Code&Title ***: SUR202 Principles of Surveying-II***
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Dr. Cheki Dorji, Namgay Om and Mr. Leki Dorji
Module Coordinator : Mr. Leki Dorji

General Objective:

The module aims to introduce the concepts of geodetic surveying and applications of modern surveying techniques. Through this module students will acquire the knowledge and practical skills of geodetic surveying.

Learning Outcomes:

On completion of the module, students will be able to:

1. Perform triangulation surveying by theodolite.
2. Identify the causes of errors in surveying and apply adjustments.

3. Set out horizontal and vertical curves by different methods.
4. Carry out layoutof buildingand location of bridge piers.
5. Conduct traversing using a total station.
6. Conduct topographical survey by total station.
7. Read topographical maps

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	2	30
Practical	3	45
Tutorial	1	15
Written assignment	1	15
Independent study	1	15
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test-I: in 5th week, Unit I-II	1	10	25
1.2	Term Test-II: in 10th week, Unit IV-V	1	10	
1.3	Assignment I: in 6th week, Unit I-II (Based on solving problems related with setting out works like buildings, bridges, and curves). • Correct Formulae • Methods/steps/procedures • Conclusion/Correct Results Assignment II: in 11th week, Unit III (Based on triangulation and problems solving on adjustment of errors in surveying). • Correct Formulae • Methods/steps/procedures • Conclusion/Correct Result	2	0.5 1.5 0.5 0.5 1.5 0.5	
2	Continuos Assessment (Practical)			
2.1	Regular Assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in	1	15 1.5 4.5 3	25

	order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).		3 3	
2.2	Practical examination/Viva-Voce/Quiz:		10	
3	Semester End Examination: 3hours, closed book.	1	50	50

Pre-requisites: SUR201 Principles of Surveying-I

Subject Matter:

Unit I: Triangulation

1.1 Triangulation system, strength of figures, selection and intervisibility of stations.
1.2 Signals & towers, base line measurement.
1.3 Reduction to mean sea level, satellite stations, reduction to centre.

Unit II: Adjustment Computation

2.1 Theory of errors and triangulation adjustments.
2.2 Types of errors, principle of least squares, laws of weights, normal equations.
2.3 Method of correlates, station and figure adjustments.

Unit III: Curves

3.1 Classification of curve.
3.2 Elements of circular curves.
3.3 Theory and methods of setting out simple horizontal and vertical curves.

Unit IV: Project Surveys

4.1 Location surveys- for buildings, highways and bridges.

Unit V: Introduction to Modern Surveying

5.1 Total Station- parts of total station.
5.2 Horizontal and vertical angle measurements, adjustments, observation of readings.
5.3 Data processing procedures.
5.4 GPS-parts of GPS, observation of readings, data processing procedures.

Unit VI: Contouring

6.1. Definition and characteristics of contours.
6.2. Use of contour maps.
6.3. Direct and indirect methods of contouring.

List of Practicals:

1. Carry out Triangulation on a given area.
2. Compute the adjusted coordinates of Triangulation Stations.
3. Plot coordinates at a given scale using a total station
4. Layout a simple horizontal and vertical circular curves.
5. Layout of building.
6. Conduct traversing by using total station.
7. Conduct topographical survey using Total Station.

Reading List:

Essential Reading

1. Agor, R. (2000). Surveying Volume II (3 ed.). New Delhi: Khanna Publications.
2. Arora, R. (2000). Surveying Volume II (3 ed.). New Delhi: Khanna Publications.
3. Duggal, S. K. (2007). Surveying –II (2 ed.). New Delhi: Tata Mcgraw Hill.
4. B.C.Pumia. (2000). Surveying – II (3 ed.). New Delhi: Laxmi Publications.
5. Rangwala, S.C. (2005). Surveying and Leveling (2 ed.). New Delhi: Charotar Publishing House.

Additional Reading

1. Agor, R. (2000). Surveying Volume I (3 ed.). New Delhi: Khanna Publications.

Date: Janaury 31, 2017

Module Code & Title : FED201 Engineering Geology
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mr. Sangey Pasang and Mrs. Tshering Cheki
Module Coordinator : Mr. Sangey Pasang

General Objective:

The module introduces students to the application of geologic science to engineering practice. Through this module, students will be able to recognise the geologic factors that affects the location, design, construction, operation and maintenance of engineering works.

Learning Outcomes:

On completion of the module, students will be able to:

1. Identify various types of rocks and minerals.
2. Measure the strength of various rocks, minerals and their relationship with civil engineering.
3. Distinguish various types of earthquake and possible measures to prevent damages to civil engineering structures.
4. Explain mass movement and their influence on civil engineering works.
5. Identify types of geological structures and their importance in civil engineering
6. Analyse the ground conditions through geophysical surveys.
7. Investigate sites for civil engineering projects.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours

Lecture	2	30
Practical	2	30
Independent study/self-directed learning	4	60
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			25
1.1	Term Test I: in 5th week, Unit I-IV Term Test II: in 10th week, Unit V-IX	2	20	
1.2	Presentations and group discussions: in 11th week, Unit IX-XI Introduction:1 Identification of geological features:2 Participation:1 Difference between different features: 1	1	5	
2	Continues Assessment (Practical)			
2.1	Regular assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).	1	15 1.5 4.5 3 3 3	25
2.2	Practical Examination/Viva-voce/Quiz:	1	10	
3	Semester End Examination: 2 hours, closed book.	1	50	50

Pre-requisites: None

Subject Matter:

Unit I: Introduction:

1.1 Branches of geology.
1.2 Engineering Geology and its applications.

Unit II: The Earth as a System and General Geology

2.1 Universe and solar system.
2.2 Composition of atmosphere, Lithosphere, Hydrosphere, Cryosphere, Atmosphere and their interactions.
2.3 Shape, size and interior of the solid earth.
2.4 Geological Agents –exogenous and endogenous agent.
2.5 Weathering of rocks and River as a geological agent.
2.6 Classification of earth movements.

Unit III: Mineralogy

3.1 Definition of a mineral and a crystal.
3.2 Mode of formation of minerals.
3.3 Common rock forming minerals and their abundance.
3.4 Different methods of study of minerals.

Unit IV: Common Rock Forming Minerals

4.1. Types of rock forming minerals.
4.2. Special features of silicate minerals.
4.3. Important details of common rock forming minerals.

Unit V: Petrology

5.1. Structure of the earth.
5.2. Definition and classification of a rock.
5.3. Formation of different groups of rocks.
5.4. Rock cycle and Civil engineering importance of petrology.

Unit VI: Igneous Rocks

6.1. Common forms of igneous rocks.
6.2. Classification of igneous rocks.
6.3. Structure and texture of igneous rocks.
6.4. Suitability of igneous rocks for building and foundation.
6.5. Description of relatively common igneous rock types.

Unit VII: Sedimentary rocks

7.1. Classification of sedimentary rocks.
7.2. Sedimentary rocks on the earth crust.
7.3. Structures and texture of sedimentary rocks.
7.4. Descriptive study of common sedimentary rocks.

Unit VIII: Metamorphic Rocks:

8.1 Metamorphism.
8.2 Common Structure and texture of metamorphic rocks.
8.3 Classification of metamorphic rocks.
8.4 Descriptive study of common metamorphic rocks.

Unit IX: Earth Processes and their Consequences

9.1. Outcrop, strike, dip, Folds, faults, joint, unconformities.
9.2. Common symbols to indicate some geological structures.
9.3. Effect of folding, faulting and joints and their civil engineering importance.

Unit X: Earthquakes

10.1. Earthquake terminology.
10.2. Classification and causes of earthquake.
10.3. Earthquake waves.
10.4. Intensity and magnitude of earthquake.
10.5. Locating the epicentre and depth of focus of an earthquake.

Unit XI: Geophysical and Geological Mapping

11.1. Seismic resistivity, electrical resistivity, magnetic resistivity, acoustic resistivity and Gravitational methods.
11.2. Geological time scale, time unit v/s rock units, toposheet reading, geologic map reading and preparation of geologic maps.
11.3. Geology of Bhutan- different geological zones.

Unit XII: Site investigation and selection, Remote Sensing, GIS and GPS

12.1 Criteria and factors for site selection for mega and micro civil engineering projects: Dams, tunnels, waste/radioactive disposal sites, constructions sites, new roads.
12.2 Remote Sensing and Application: Introduction and Basic Concepts of Remote sensing, Remote Sensing Systems, Digital Image Processing Image, Remote Sensing Applications.
12.3 Global positioning System (GPS): Introduction to GPS, GPS for ground truth collection.
12.4 Geographic Information System: Introduction to GIS, Geo-referencing and Projection, Data Models and Data Structures, Spatial Database Management Systems.

List of Practicals:

1. Identification of rocks and their engineering properties.
2. Identification of minerals and their engineering properties.
3. Exercise on structural geological maps.
4. Aerial photo interpretation for terrain evaluation and study of satellite imageries.
5. Demonstration of GPS surveying.

Reading List:

Essential Reading

1. Kesavulu, N. C. (2009). Textbook of Engineering Geology (3 ed.). New Delhi: Macmillan Publisher.
2. Varghese P. C. (2012). Engineering Geology for Civil Engineers. New Delhi: PHI Learning Private Limited.
3. Reddy, M.T. M. (2002). Engineering Geology Practical (2 ed.). New Delhi: New Age International.
4. John R. J. (2003). Remote Sensing of the Environment and Earth Resource Perspective (1 ed.). New Delhi: Pearson Education.
5. Waltham,Tony. (2002).Foundations of engineering geology(2ed)

Additional Reading

1. Kesavulu. N.C. (1993). Text book of Engineering Geology (2 ed.). New Delhi: Macmillan Publisher.
2. Tony W. (2001). Foundations of Engineering Geology (1 ed.). New York: Chapman & Hall.
3. Singh. P. (2003). Engineering and General Geology (6 ed.). New Delhi: S.K. Kataria and Sons.

Date: Janaury 31, 2017

Module Code & Title : TSM203 Structural Mechanics-I
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mrs. Monika Thapa and Ms. Lily Gurung
Module Coordinator : Mrs. Monika Thapa

General Objective:

This module aims to develop student's ability to analyse determinate and indeterminate structures by various methods. The analysis involves determining the internal forces, moment and deflection in the structural members.

Learning Outcomes:

On completion of the module, students will be able to:

1. Identify the behaviour of structures due to loads acting on the structure.
2. Analyse the determinate structures using equations of equilibrium.
3. Compute the degree of indeterminacy.
4. Analyse the indeterminate beams and frames using method of consistent deformations.
5. Analyse indeterminate beams and frames using slope deflection method, moment distribution method and rotation contribution method.
6. Analyse the indeterminate beams and frames using energy theorems.
7. Determine the deflection of perfect frames by Castigliano's theorem, unit load method and Maxwell's reciprocal theorem.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Independent study	4	60
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test: in 5th week, Unit I-III) Term Test II: in 10th week, Unit IV-V	2	20	30
1.2	Assignment I: in 6th week, Unit I-III (Analyse the indeterminate beams and frames using method of consistent deformations). – Complexity of the problem chosen (1-mark) – Right interpretations of unknowns/ redundant forces with figures (1-mark) – Correct analysis (2.5-marks) – Correct drawing of bending moment diagram (0.5-mark) Assignment II: in 12th week, Unit IV-VI (Analyse and determine slope and deflections of indeterminate beams and frames using slope deflection method, moment distribution method and rotation contribution method). – Complexity of the problem chosen (0.5-mark) – Accurate interpretations of unknowns/ redundant forces with figures and correct determination of constants/factors if required (1.5 marks) – Correct analysis (2.5-marks) – Proper drawings and interpretations (0.5-mark)	2	10	
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites: TSM101 Engineering Mechanics, TSM202 Strength of Materials

Subject Matter:

Unit I: Introduction to Structural Analysis

1.1 Forms of structures.
1.2 Loads and forces.
1.3 Idealization of structures.
1.4 Elastic and linear behaviour of structures.
1.5 Principle of superposition.
1.6 Support and connection.
1.7 Analysis of determinate structures.

Unit II: Analysis of Indeterminate beams and Frames

2.1 Reaction components.
2.2 External redundancy.
2.3 Statically indeterminate beams.
2.4 Degree of redundancy of articulated structures.
2.5 Degree of redundancy of rigid jointed frames.
2.6 Methods of analysis.

Unit III: Method of Consistent Deformation

3.1 Unit load method.
3.2 Maxwell's Reciprocal Theorem applied to Perfect frames.
3.3 Statically indeterminate beams and frames.
3.4 Betti's reciprocal theorem.

Unit IV: Slope Deflection Method

4.1. Fundamental Equations.
4.2. Continuous beams and frames without and with joint translation.
4.3. Portal Frames without and with side sway.

Unit V: Moment Distribution Method

5.1 Fundamental Proposition.
5.2 Continuous beams and frames without and with joint translation.
5.3 Portal Frames without and with side sway.
5.4 Sinking of supports.

Unit VI:Rotation Contribution Method (Kani's Method)

6.1. Fundamental Proposition.
6.2. Continuous beams and frames without joint translation.
6.3. Portal Frames without and with side sway.

Unit VII: Energy Theorems

7.1 Deflection by Castigliano's theorem.
7.2 Analysis of statically indeterminate beams.

7.3 Frames and redundant frame by minimum strain energy.
7.4 Principle of virtual work.

Reading Lists:

Essential Reading

1. Redd, C.S. (2008). Basic Structural Analysis (4 ed.). New Delhi: Tata McGraw-Hill.
2. Vazirani V.N., &.Ratwani, M.M. (2002). Analysis of Structures - Vol. I (3 ed.). New Delhi: Khanna Publishers.
3. Vazirani V.N., &.Ratwani, M.M. (2002). Analysis of Structures - Vol. II (3 ed.). New Delhi: Khanna Publishers.
4. Ganesan, T. P. (2000). Model Analysis of Structures (2 ed.). New Delhi: Universities Press.
5. Punmia, B.C. (1988). Strength of Materials and Mechanics of Structures-Vol. II. New Delhi: Standard Publishers & Distributors.

Additional List

1. Norris, C.H.,Wilber, J.H., &Utku, S. (2005). Elementary Structural Analysis (2 ed.). New Delhi: Tata McGraw Hill.
2. Norris, C.H., Wilber, J.H., &Utku, S. (1976). Elementary Structural Analysis. Tokyo: McGraw Hill.
3. Rao, D.S.P. (1996). Structural Analysis- A Unified Approach. Hyderabad: Universities Press.
4. Coates, R.C., Coutie, M.G., & Kong, F.K. (1980). Structural Analysis. Hongkong: ELBS & Nelson.
5. Ramamrutham, S. & Narayan, R. (2002). Theory of Structures (3 ed.). New Delhi: Dhanpat Rai Publishing Company.
6. Jindal, R. L. (1986). Elementary Theory of Structures (2 ed.). New Delhi: S.Chand& Company.
7. Sinha, N.C. & Gupta S.K. (1987). Elements of Structural Mechanics. New Delhi: S.Chand& Co.

Date: Janaury 31, 2017

BE (Third Year) – Fifth Semester

Semester V				Contact Hours			Marks		
							Theory		Pract
#	Code	Module	Credit	L	T	P	CA	EX	CA
1	MAT311	Numerical Methods with Programming	12	3	1	1	25	50	25
2	DOS301	Design of Steel Structures-I	12	3	1	0	30	70	0
3	EVE301	Hydrology	12	3	1	0	30	70	0
4	TSM304	Structural Mechanics-II	12	3	1	0	30	70	0

5	FED302	Soil Mechanics	12	3	1	2	25	50	25
6	MGT301	Entrepreneurship Development	12	2	2	0	70	30	0
Total				**17**	**7**	**3**	**210**	**340**	**50**
			72	**27**			**600**		

Module Code &Title : **MAT311 Numerical Methods with Programming**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. S.T.Venkatesan**

General Objective:

This module will develop the student's ability to formulate engineering problems in terms of mathematical model and to interpret the solution. The module introduces students to mathematical techniques that support engineering modules and provides Numerical Methods for analysis of practical engineering problems. It will describe the principle techniques available for analysing the behaviour of simplex method and to illustrate how the techniques would be applied in practical settings.

Learning Outcomes:

On completion of the module, students will be able to:

1. Apply the method of least squares to fit the appropriate curve.
2. Use the appropriate interpolation formula to find the missing data.
3. Determine critical conditions for solutions of equations, using the Eigen value methods.
4. Solve system of linear equations numerically and to evaluate critically different approaches and techniques for their implementation.
5. Solve numerical differentiation, numerical integration, O. D. E's using numerical techniques, having critically appraised different techniques and select the most appropriate.
6. Formulate Linear Programming Problems
7. Solve Linear Programming Problems by Simplex Method.
8. Apply appropriate scientific package to solve the numerical problems.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Practical	1	15
Independent study/self-directed learning	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)

1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit V Term Test II: in 10th week, Unit II	2	20	25
1.2	Assignment I: in 7th week, Unit II (Estimating the unknown values using appropriate interpolation formulae). Assessment criteria Presentation (0.5 Marks) Selection of appropriate formula(0.5 Marks) Procedure (1 Mark) Final answer(05Marks)	1	2.5	
1.3	Assignment II: in 13th Unit III (Finding area, acceleration, velocity, slope, etc., using appropriate numerical differentiation and integration formulae). Assessment criteria Presentation (0.5 Marks) Selection of appropriate formula(0.5 Marks) Procedure (1 Mark) Final answer(05Marks)	1	2.5	
2	Continuos Assessment (Practical)			
2.1	Regular Assessments: • Procedure. • Algorithm. • Flow chart. • MatLAB programming. • Input-output.		10 2 2 2 2 2	25
2.2	Practical Exam/Assignments on Numerical Methods	1	10	
2.3	Viva-Voce/Test on L.P.P	1	5	
3	Semester End Examination: 3 hours, closed book.	1	50	50

Pre-requisites: CPL101

Subject Matter:

Numerical Analysis with Programming:

Unit I: Curve fitting

1.1 The method least squares fitting of Straight line,
1.2 Second degree parabola and Exponential curve

Unit II: Interpolation

2.1 Finite Differences.
2.2 Forward, Backward and central differences.
2.3 Newton's forward and backward interpolation formula.
2.4 Gauss's forward and backward.
2.5 Stirling's interpolation formula.
2.6 Lagrange interpolation and divided differences.

Unit III: Numerical Differentiation:

3.1 Numerical differentiation at the tabulated points with forward.
3.2 Backward and central differences.

Unit IV: Numerical integration:

4.1 Trapezoidal rule.
4.2 Simpson's 1/3 Rule.
4.3 Simpson's 3/8 Rule.
4.4 Romberg's method of integration.

Unit V: System of linear Algebraic equations:

5.1 Calculation of dominant Eigen value by Power method and Jacobi's method
5.2 System of linear equations: Gauss's elimination method, Gauss's Jordan elimination method.
5.3 Gauss Seidal iteration method and Gauss Jacobi's iteration method.
5.4 Solution of Nonlinear equations: Numerical solution of algebraic and transcendental equations.
5.5 Regula- Falsi method and Newton-Raphson's method.

Unit VI: Numerical solution of first order ordinary differential equations:

6.1 Taylor Series method.
6.2 Euler's and Modified Euler's method.
6.3 Picard's method.
6.4 Runga-Kutta method of 2nd and 4th orders.

Unit VII: Introduction to Linear Programming:

7.1 Introduction: Linear Programming Problem and its Engineering application.
7.2 Statement of the problem and Mathematical formulation.
7.3 Classification of optimization problems and optimization techniques.
7.4 Classical optimization Techniques: Single variable, multivariable with no constraint. with equality constraints and with inequality constraints.
7.5 Solving by Graphical methods and special cases.
7.6 Solving by Simplex method – Solution of a system of linear simultaneous equations, pivotal reduction of a general systems of equations.

Practicals: Simulating Units I to VI using scientific package.

List of Practical:

1. Write a program to find the factorial value of a number. It should display error message, if a negative or non-integer is entered.
2. Write a program to find the smallest real positive roots of nonlinear equation using Bisection Method.
3. Write a program to find the smallest real positive roots of nonlinear equation using Regula- Falsi Method.
4. Write a program to find the smallest real positive roots of nonlinear equation using Newton-Raphson's Method.
5. Write a program to solve the system of linear equations using Gauss – Seidal Iteration Method.
6. Write a program to solve the system of linear equations using Gauss – Jacobi Iteration Method.
7. Write a program to find the numerically largest Eigen value of a square matrix by Power Method.
8. Write a program to find all Eigen value of a square matrix by Jacobi's Method.
9. Write a program to integrate numerically using Trapezoidal rule.
10. Write a program to integrate numerically using Simpson's rule.

Reading Lists:

Essential Reading

1. Grewal, B.S (2003). Numerical Methods in Engineering & Science (6 ed.). New Delhi: Khanna Publishers, New Delhi.
2. M.K.Jain., S.R.K.Iyengar., and R.K.Jain. (2002). Numerical Methods Problems and Solutions. New Delhi: New Age International (P) Ltd Publishers.
3. Dixit, J.B. (2016). Numerical Methods (1 ed.). New Delhi. University Science Press.
4. Hamdy, A. Taha. (2006). Operations Research an Introduction (7 ed.). New Delhi: Prentice-Hall of India Private Ltd.
5. Dipak Chatterjee (2005). Linear Programming and Game Theory (1 ed.).New Delhi: Prentice-Hall of India.
6. Cleve, B. Moler. (2004). Numerical Computing with MATLAB. New York: Siam Press.

Additional Reading

1. Won Y. Yang et al. (2005). Applied Numerical Methods Using MATLAB. New Delhi: Wiley India Pvt. Ltd.
2. Babu Ram. (2010), Numerical Methods (1 ed). New Delhi: Pearson.
3. Schaum's Outline Series. (2003). Operations Research. Singapore: McGraw Hill.

Date: Febraury4, 2017

Module Code & Title : **DOS301 Design of Steel Structures-I**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mrs. Monika Thapa and Mr. Tshewang Nidup**
Module Coordinator : **Mr. Tshewang Nidup**

General Objective:

The general objective of this module is to provide students with good exposure to the use, properties and behaviours of steel as a structural material. Students will be introduced and familiarized with the general design philosophies for the design of various steel structural components and their connections. The designs procedures are based on the Codal Requirements for Structural Steel published by the relevant International standards. The principles underlying the code design provision, as well as their application to practical design problems will be explained. The module will also introduce the basic concepts on the application of timber as a structural material.

Learning Outcomes:

On completion of the module, students will be able to:

1. Distinguish between different designs approaches like Elastic, Plastic and Limit State Methods in steel structures design.
2. Design and prepare details of simple bolted and welded connections.
3. Suggest suitable steel sections to be used as Tension members
4. Analyse and design the members under compression including built-up as well as laced and battened columns.
5. Design members under bending including built-up beams and plate girders with stiffeners.
6. Design members under both bending and compression
7. Design Column Base for various loading conditions
8. Recommend appropriate Beam–Column Connections.
9. Propose suitable timber sections to be used as columns beams and trusses.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Assignment	1	15
Independent study	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VII	2	20	30
1.3	Assignment I: in 6th week, Unit I-III (Design simple structural connections and compression members). Conceptual understanding : 2 Application of the concept : 2 Accuracy and correctness : 1	2	10	

	Assignment II: in 12th week, Unit IV-VII (Design beams, columns, footings and timber structures). Conceptual understanding : 2 Application of the concept : 2 Accuracy and correctness : 1			
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites: TSM202 Strength of Materials, TSM203 Structural Mechanics-I and TSM304Structural Mechanics-II

Subject Matter:

Unit I: Introduction:

1.1. Advantages and disadvantages of structural steel.
1.2. Metallurgy of steel
1.3. Properties of Structural Steel – Yield strength an ultimate strength
1.4. Ductility, Fatigue in steel
1.5. Specifications and Codes
1.6. Design Methods

Unit II: Design Methods

2.1 Plastic Analysis and Design.
2.2 Section classification
2.3 Limit state design, Other design requirement

Unit III: Simple Connections:

3.1 Types of connections
3.2 Bolted connections
3.3 Welded connections.
3.4 Bolt Groups
3.5 Weld Groups

Unit IV: Tension Members:

4.1 Types of tension members,
4.2 Net and effective areas,
4.3 Design of tension members,
4.4 Lug angles, splices and gusset plates.

Unit V: Compression Members:

5.1 Struts and Columns Capacity theory
5.2 Effective lengths
5.3 Design of axially loaded columns
5.4 Eccentrically loaded columns (Beam – Column)
5.5 Built up columns
5.6 Encased columns.

Unit VI: Flexural members (Beams):

6.1 Lateral stability of beams,
6.2 Bending, bearing and shear stresses,
6.3 Web buckling and web crippling.
6.4 Built-up sections,
6.5 Design of laterally supported and unsupported beams.
6.6 Plate Girders including stiffeners, connections and curtailment of flange plates.

Unit VII: Design of Eccentric Connections:

7.1 Beam-column connections.
7.2 Welded shear connections.
7.3 Moment resistant connections

Unit VIII: Column Bases & Footings:

8.1 Simple bases, gusseted base and column bases.
8.2 Design of Foundation bolts,
8.3 Gusset base and Grillage footing.

Unit IX: Timber Structures:

9.1 Introduction to Timber as a Structural Material
9.2 Structural Timber Codes
9.3 Design of Timber beams,
9.4 Design of Timber Columns and Joints.

Reading List:

Essential List

1. Duggal, S.K., (2010). Limit state design of Steel Structures (4th ed.). New Delhi: Tata McGraw Hill Publishing Company Ltd.
2. Kulak, G.L & Grondin. G.Y,(2006). Limit State Design in Structural Steel (8th ed).Canadian Institute of Steel Construction, Ontario
3. Institute of Steel Development and Growth (INSDAG) Steel Design Learning Material

4. Punmia, B.C., Jain, A.K. and Jain, A.K., (2006). Comprehensive Design of Steel Structures. New Delhi: Laxmi Publications (P) Ltd.
5. Vazirani, V.N. and Ratwani, M.M., (1979). Steel Structures and Timber Structures. New Delhi: Khanna Publishers.

Additional List

1. IS: 800- 2007, Code of Practice for General Construction in Steel. New Delhi: Bureau of Indian Standards
2. SP:6 (1) – 1964, Hand Book for Structural Engineers (1. Structural Steel Sections). New Delhi: Bureau of Indian Standards
3. IS: 883- 1994, Design of Structural Timber in Building – Code of Practice. (4th revision) New Delhi: Bureau of Indian Standards

Date: Janaury 31, 2017

Module Code & Title : **EVE301 Hydrology**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Leki Dorji and Mr. Tshering Tobgyel**
Module Coordinator : **Mr. Leki Dorji**

General Objective:

This module aims to enable students to understand hydrological processes and the hydrological cycle. It covers fundamental topics such as the hydrological cycle, losses, hydrographs besides others. Students will be introduced to the variation in the occurrence, movement, and distribution of water in the natural system. Students will also develop the ability to calculate runoff by different methods and propose flood control measures.

Learning Outcomes:

On completion of the module, the students will be able to:
1. Analyse hydrological cycle and the variations in flow and dispersions.
2. Measure and estimate the precipitation.
3. Calculate water losses due to evapo-transpiration.
4. Calculate runoff by different methods.
5. Derive unit hydrograph and its application.
6. Estimate the peak flood characteristics by different methods.
7. Determine the yield of groundwater.
8. Choose the appropriate flood control measures.
9. Exhibit flood routing.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Written assignment	1	15
Independent study	3	45

Total	120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-IV Term Test II: in 10th week, Unit V-VIII	2	20	30
1.2	Assignment I: in 6th week, Unit II (Measure and estimate the precipitation, calculation on runoff by different methods). • Correct Formulae • Methods/Steps/Procedure • Correct Results Assignment II: in 11th week, Unit VII-VIII (Estimate the peak flood characteristics by different methods and determine the yield of groundwater). • Correct Formulae • Methods/Steps/Procedure • Correct Results	2	1.5 2.0 1.5 1.5 2.0 1.5	
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites:FMH201 Fluid Mechanics, FMH202 Hydraulics

Subject Matter:

Unit I: Introduction

1.1 Hydrologic cycle, Forms of precipitation.
1.2 Scope of hydrology, Hydrological data.
1.3 Hydrologic equation.

Unit II: Precipitation

2.1 Types of precipitation, measurement of precipitation-rain gauges.
2.2 Estimates of missing data and adjustment of records.
2.3 Mean Aerial depth of precipitation, Arithmetic average method, Theissen polygon method, Isohyetal method.
2.4 Optimum rain-gauge network design, Depth-Area-duration (DAD) curves, Hyetograph, Mass curve, Analysis of rainfall data.
2.5 Correlation of rainfall records, Recurrence interval by California method, Hazen's method, Kimball's method-frequency of storm, Maximum Intensity.
2.6 Duration curve, Maximum-depth-duration curve, Moving averages curve, Design storm and Probable Maximum Precipitation(PMP).

Unit III: Water Losses

3.1 Evaporation-Factors affecting evaporation, Dayton's law.

3.2 Methods of estimating lake evaporation, Evaporation pans, Colorado sunken pan, PicheEvaporimeter, Measures to reduce lake evaporation, Soil evaporation.

3.3 Lysimeter, Transpiration-Evapotranspiration-Blaney Criddle method, Evaporation index method, Penman's Equation.

3.4 Factors affecting Evapotranspiration, Infiltration-Horton's curve, Methods of determining infiltration-Double-ring infiltrometer-Tube infiltrometer, Infiltration indices.

3.5 φindex,W index, fave index-watershed leakage, Water Balance equation.

Unit IV: Runoff

3.1 Classification of streams, Isochrones, Factors affecting runoff.

3.2 Estimation of runoff-empirical formulae, curves and tables, Infiltration method.

3.3 Unit Hydrograph theory.

Unit V: Hydrographs

5.1 Components of a hydrograph, factors affecting hydrograph.

5.2 Separation of stream flow components, unit hydrograph.

5.3 Derivation of unit hydrograph, average unit hydrograph, satrix method.

5.4 Bernard's distribution graph, instantaneous unit hydrograph.

5.5 Synthetic unit hydrograph, applications of unit hydrograph.

Unit VI: Stream Gauging

6.1 Methods of stream gauging-current meter gauging, rating of current meter.
6.2 Stage-discharge rating curve, selection of site for a stream gauging station.

Unit VII: Ground Water

7.1 Aquifer, aquiclude, aquifuge and aquitard, confined and unconfined aquifers, storage coefficient.
7.2 Transmissibility, Dupuit's equations for confined and unconfined wells.
7.3 Assumptions, specific capacity, yield test, pumping test, recuperation test.

Unit VIII: Flood Estimation and Control

8.1 Definition of flood, standard project flood (SPF)-maximum probable flood (MPF), probable maximum precipitation (PMP).
8.2 Design flood, estimation of peak flood- physical indications, empirical formulae and curves, rational method.
8.3 Unit hydrograph method and flood frequency studies, risk, reliability and safety factor, methods of flood control-flood control by reservoirs.
8.4 Retarding basins, Levees, Soil conservation measures, flood plain zoning, flood control economics, flood forecasting and warning.

Unit IX: Flood Routing

9.1. Reservoir routing, modified pulse method, ISD method,
9.2. Stream flow routing, Muskingum method

Unit X: Hydraulics of Alluvial Rivers and Water Logging

10.1. Sediment load, bed formation, mechanics of sediment transport-critical tractive force. Regimes of flow, river training & bank protection works.
10.2. Causes, preventive and curative measures of water logging problems, drainage of irrigated lands, saline and alkaline lands.

Reading Lists:

Essential Reading

1. Bhattacharya, P.K. (1996). Elements of Applied Hydrology. New Delhi: Khanna Publishers.
2. Gupta, B.L. (2004). Water Resource Engineering and Hydrology. New Delhi: Khanna Publishers.
3. Manning, J.C. (1996). Applied Principles of Hydrology (3 ed.). Prentice Hall.
4. Subramanya, K. (2008). Engineering Hydrology (3 ed.). New Delhi: Tata McGraw Hill.
5. Raghunath, H.M. (2006). Hydrology: Principles, Analysis and Design. New Delhi: New Age International Publishers.

Additional Reading

1. Reddy, J.R. (2007). A Textbook of Hydrology. New Delhi: Laxmi Publications.
2. Todd, D.K. (2006). Groundwater Hydrology (2 ed.). New Delhi: Wiley India (P) Limited.
3. Vedula, S. (2007). Water Resource Systems. New Delhi: Tata McGraw-Hill.
4. Chow, V.T., Maidment, D.R., Mays, L.W. (1988). Applied Hydrology. McGraw Hill.
5. Garg, S.K. (2005). Hydrology and Water Resources Engineering. New Delhi: Khanna Publishers.

Date: Janaury 31, 2017

Module Code & Title : TSM304Structural Mechanics-II
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Ms. Lily Gurung and Mrs. Monika Thapa
Module Coordinator : Mrs.Monika Thapa

General Objective:

The general objective of this module is to provide the basic concept for the analysis of fixed beams, frames, bridges, arches and suspension bridges through the introduction of column analogy method, matrix and influence lines methods for analysis of fixed beams, portal frames, columns, arches and suspension bridges. Plastic analysis is also introduced to analyze steel beams and portal frames.

Learning Outcomes:

On completion of the module, students will be able to:

1. Analyse the indeterminate beams, frames using column analogy method.
2. Determine the behavior of structures due to moving loads.
3. Draw the influence line diagrams for various types of moving loads on the beams.
4. Implement influence lines in the design of structures imposed to moving loads.
5. Analyse the simple structures using matrix method.
6. Perform the analysis for the various types of arches for different loads as well as support conditions.
7. Analyse the various types of suspension bridges for different loads as well as support conditions.
8. Determine the collapse load, maximum plastic moment using plastic method of analysis.
9. Explain the basic parameters of theory of elasticity and identify its importance in analysis.
10. Derive various compatibility and equilibrium equations of the theory of elasticity for elements and implement it in the analysis of elements.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours

Lecture	3	45
Tutorial	1	15
Independent study/self-directed learning	4	60
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-V	2	20	30
1.2	Assignment I: in 6th week, Unit I-III (Analyse the indeterminate beams, frames using column analogy method and determine influence line diagram for different structures). – Complexity of problem taken (1-mark) – Proper interpretations (0.5-mark) – Accurate analysis (2.5-marks) – Correct determinations and drawings (1-mark) Assignment II: in 11th week, Unit IV-VI (Perform analysis for different types of arches and suspension bridges). – Type of problem chosen (1-mark) – Proper interpretations and approach (0.5- mark) – Appropriate use of boundary conditions and equations (0.5-marks) – Correct analysis (2-marks) – Correct determinations and drawings (1-mark)	2	10	
2	Semester End Examination: 3hours, closed book.	1	70	70

Pre-requisites: TSM203 Structural Mechanics-I

Subject Matter:

Unit I: Column Analogy Method

1.1 Development of Column Analogy Method and its application for the analysis of Fixed Beams, Portal Frames, Closed Frames and Gable Frames.

Unit II: Introduction to Matrix Method Analysis

2.1 Matrix Method analysis of structures by flexibility or force method.
2.2 Development of matrix for pin jointed truss by stiffness or displacement method of analysis.
2.3 Its application to simple indeterminate beams and frames.

Unit III: Rolling loads and Influence Lines

3.1 Single concentrated load, UDL longer than the span of girder.
3.2 UDL shorter than the span of girder.
3.3 Influence Line Diagrams (ILD) for SF and BM for beams.
3.4 Girder with beams.
3.5 Muller-Breslau's Principle and its applications.

Unit IV: Arches

4.1. Linear Arch, Eddy's Theorems, Three hinged Arches, Moving load on Three hinged Arches, Two hinged Arches, Moving load on Two hinged Arches, Temperature and Rib shortening effects on Two hinged Arches and Fixed Arches.

Unit V: Suspension Bridges

5.1 Equation of Cables, Cables and Suspension bridges, Stiffening girders-three and two hinged stiffening girders, ILD for three hinged and two hinged stiffening girders.

Unit VI: Plastic Analysis

6.1 Plastic moment, Plastic hinge, Load factor, Method of Analysis, Plastic analysis for beams and portal frames.
6.2 Determination of collapse load for some standard case of beams.

Unit VII: Elementary Theory of Elasticity

6.1 State of stress at a point; stress tensor, strain tensor, compatibility equation, equilibrium equation, Generalized Hook's Law, Boundary conditions.

Reading Lists:

Essential Reading

1. Bhavikatti, S.S. (2005). Structural Analysis-Volume II (2 ed.). New Delhi: Vikas Publishing House Private. Limited.
2. Punmia, B.C. (1988). Strength of Materials and Mechanics of Structures-VolumeII. New Delhi: Standard Publishers & Distributors.
3. Ramamrutham, S. & Narayan, R. (2002). Theory of Structures (3 ed.). New Delhi: Dhanpat Rai Publishing Company.
4. Vaidyanathan, R &Perumal, P. (2012). Structural Analysis-Volume II (3 ed.). New Delhi: Laxmi Publications (P) Limited.
5. Vazirani V.N., & Ratwani, M.M. (2002). Analysis of Structures - Volume II (3 ed.). New Delhi: Khanna Publishers.

Additional Reading

1. Reddy, C.S. (2008). Basic Structural Analysis (4 ed.). New Delhi: Tata Mc Graw-Hill.
2. Ganesan, T. P. (2000). Model Analysis of Structures (2 ed.). New Delhi: Universities Press
3. Norris, C.H.,Wilber, J.H., &Utku, S. (2005). Elementary Structural Analysis (2 ed.). New Delhi: Tata McGraw Hill.
4. Norris, C.H., Wilber, J.H., &Utku, S. (1976). Elementary Structural Analysis. Tokyo: McGraw Hill.
5. Rao, D.S.P. (1996). Structural Analysis - A Unified Approach. Hyderabad: Universities Press.
6. Coates, R.C., Coutie, M.G., & Kong, F.K. (1980). Structural Analysis. Hongkong: ELBS & Nelson.
7. Jindal, R. L. (1986). Elementary Theory of Structures (2 ed.). New Delhi: S.Chand& Company.
8. Sinha, N.C. & Gupta S.K. (1987). Elements of Structural Mechanics. New Delhi: S.Chand& Co.

Date: Janaury 31, 2017

Module Code & Title **:FED302 Soil Mechanics**
Programme **:BE in Civil Engineering**
Credit **: 12**
Module Tutor **: Mr. Karma Tempa and Mrs. Tshering Cheki**
Module Coordinator **: Mr. Karma Tempa**

General Objective:

The general objective of this module is to provide the basic concept of soil properties, Identification, Classification, Effective Stress and Relative Phenomenon, Permeability, Seepage, Vertical Stresses below Applied Load, Compressibility & Consolidation. It will also provide cover classification and Compaction Behavior soil including its various applications in civil engineering.

Learning Outcomes:

On completion of the module, students will be able to:

1. Identify the soils based on their index properties.
2. Categorize different types of clay minerals with their structures.
3. Determine field control measures for compaction.
4. Compute effective stress and total pressure on retaining structures.
5. Compute the coefficient of permeability of different types of soil.
6. Analyze seepage through soils.
7. Perform one dimensional consolidation and compute consolidation parameters.
8. Compute shear parameters for different drainage conditions.
9. Conduct the relevant tests on soils and analysis of the data.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Practical	2	30
Tutorial	1	15
Independent study/self-directed learning	2	30
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week,Unit I-III Term Test II: in 10th week,Unit IV-VI	2	20	25
1.2	**Assignment I:** in 6th week, Unit I-III (Identify the soils based on their index properties and categorize different types of clay minerals with their structures). a. Approach/Methods b. Content c. Illustration of drawings and Free body diagrams **Assignment II:** in 11th week, Unit IV-VIII (Analysis of phase relationship and interpretation using phase diagrams, analyze and interpret compaction behaviour in lab and field, stress importance of principles of effective stress and pore water pressure and application of shear strength parameters and consolidation theory). a. Approach/Methods b. Content c. Illustration of drawings and Free body diagrams	2	1 3 1	
2	Continuous Assessment (Practical)			
2.1	Regular assessments:	1	15	25

	Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).		1.5 4.5 3 3 3	
2.2	Practical examination/viva-voce:		10	
3	Semester End Examination: 3hours, closed book.	1	50	50

Pre-requisites: None

Subject Matter:

Unit I: Introduction

1.1 Introduction to Geotechnical Engineering, Unique nature of soil, Origin & Formation of soil.

Unit II: Simple Soil Properties

2.1 Basic definitions, phase relations, functional relationship between different parameters, index properties of soil including consistency limits & grain size distribution.

Unit III: Identification & Classification of Soil

3.1 Indian standard classification system of soil, clay minerals (basic concept) & soil structure, visual identification of soil.

Unit IV: Compaction Behaviour

4.1 Compaction- theory of compaction, laboratory compaction tests, different methods of compaction control.

Unit V: Principle of Effective Stress and Relative Phenomenon

5.1 Soil water, capillarity of soil, principle of effective stress, total pressure, and neutral pressure, quick sand.

Unit VI: Permeability

6.1 One dimensional flow, permeability of soil- Darcy's law, laboratory methods of determination, permeability as a function of soil type, void ratio, soil fabric, & effective stress, pumping out tests for field determination of permeability.

Unit VII: Seepage through Soils

7.1 Two dimensional flow problems - Laplace equation, steady flow, confined flow and unconfined flow, flow nets and their characteristics, discharge passing through flow nets, seepage through anisotropic soil, total head, piezo-metric head, and elevation head.

Unit VIII: Vertical Stresses below Applied Load

8.1 Stresses in soil below loaded areas, Boussineq equation for vertical stress, concept of pressure bulb, Newmark's influence chart approximate stress distribution methods for loaded areas, Westergard's Equation

Unit IX: Compressibility & Consolidation

9.1. Effects of soil type, stress history and effective stress on compressibility.
9.2. Consolidation: factors affecting consolidation and compressibility parameters, normally consolidated and over consolidated soil.
9.3. Terzaghi's theory of one dimensional consolidation and time rate of consolidation, evaluation of compressibility and consolidation parameters from consolidometer test data, settlement in soil.

Unit X: Shear Strength Behavior

10.1 Introduction, stress at a point & Mohr's stress circle, Mohr-Coulomb failure criterion, laboratory tests for shear strength parameters, UU, CU and CD tests and their relevance to field problems, Shear strength characteristics of N-C clay and pre-consolidated clay, shear strength characteristics of sand.

List of Practicals:

1. Visual identification of soils.
2. Different methods of determining water content.
3. Specific gravity test.
4. Core cutter and sand replacement methods of determining the in-situ density, void ratio, and degree of saturation of soil.
5. Sieve analysis.
6. Hydrometer analysis
7. Atterberg's Limits.
8. Permeability tests.
9. Compaction tests.
10. Direct shear test.

11. Unconfined compression test.
12. Vane Shear test.

Reading Lists:

Essential Reading

1. Punmia, B.C. (2009). Soil Mechanics & Foundation (4 ed.). New Delhi: Laxmi Publication.
2. Murty, V. N. S. (2009). Textbook of Soil Mechanics and Foundation Engineering: Geotechnical Engineering Series (2 ed.). New Delhi: CBS Publishers.
3. Gopal, R. and Rao, A. S.R. (2006). Basic and Applied Soil Mechanics (3 ed.). New Delhi: New Age International Publisher.
4. Murthy. V.N.S. (2002). Principles of Soil Mechanics and Foundation Engineering (3 ed.). New Delhi: UBS Publishers Distributors.
5. Arora, K. R. (2009). Soil Mechanics and Foundation Engineering: Geotechnical Engineering (3 ed.). New Delhi: Standard Publishers.

Additional Reading

1. Kazimi, S. M. A.(2003). Soil Mechanics (2 ed.). New Delhi: Tata McGraw Hill.
2. Kaniraj. S.R. (2008). Design Aids in Soil Mechanics and Foundation Engineering (2 ed.). New Delhi: Tata McGraw Hill.
3. Oza. H.P. (1969). Soil Mechanics and Foundation Engineering (1 ed.). New Delhi: Charotar Book Stall.
4. Bharat. S. and Shamshor. P. (1976). Soil Mechanics and Foundation Engineering (1 ed.). Roorkee, Nem Chand and Bros.
5. Coduto. D.P. (2006). Geotechnical Engineering (2 ed.). New Delhi, Prentice-Hall.
6. Kramer. S. L. (2006). Geotechnical Earthquake Engineering (2 ed.). New Delhi, Pearson Publishers.
7. Alam.S. (2004). Modern Geotechnical Engineering (2 ed.). New Delhi: CBS Publishers.
8. Alam.S. (2004). Basic Soil Mechanics and Foundations (1 ed.). New Delhi: CBS Publishers.
9. Gulhati, S. K and Dutta, M. (2006). Geotechnical Engineering (2 ed.). New Delhi, Tata McGraw Hill.
10. Holtz. R. & Kovacs. W.D. (1981). Introduction to Geotechnical Engineering. New York: John Wiley and Sons.
11. Mittal. S.(2008). Soil Testing For Engineers (1 ed.). New Delhi: Khan a Publication.

Date: Janaury 31, 2017

Module Code and Title **:MGT301 *Entrepreneurship Development***
Programme **:BE in Civil Engineering**
Credit **:12**
Module Tutor **:Nima Dukpa and Tshewang Dema**
Module Cordinator **:Mrs. Tshewang Dema**

General Objectives:

The main objectives of module is to build entrepreneurial culture and create awareness on viable business opportunities in Bhutan and scope of entrepreneurs. It aims to infuse among them the skills and intricacies required to establish enterprise and manage it successfully. Further it also facilitate students with practical tools needed to start, finance, and manage their own business or "embark on a career in private equity".

Learning Outcomes:

On completion of the module, students will be able to:

1. Explain the opportunities, value and scope of Enterprenurship.
2. Identify the role and importance of motivational factors for the success of an enterprise.
3. Develop a viable and feasible business plan.
4. Peform economic analysis of the projects.
5. Apply the procedures and formalities for New Venture creation and management
6. Interpret institutional support and regulations for establishing or expanding a business
7. Modify intervening strategies to sustain and manage the business growth.
8. Take up entrepreneurship as preferred "career option".
9. Demonstrate problem solving and decision making in enterprise management
10. Exercise business ethics and corporate social responsibilitites.

Learning and teaching approach:

Approach	Hours per Week	Total Credit Hours
Lecture	2	30
Tutorial	2	30
Independent study/self-directed learning	4	60
Total		120

Assessment Approach:

Sl. No.	***Mode of Assessment***	***Nos.***	***Marks Allocated***	***Marks (%)***
1	**Continuous Assessment (Theory)**			
1.1	Mini project in the 5th to 10th week to study a real life business/entrepreneur in Bhutan and presentation in groups. **Assessment Criteria(Report)** • Introduction. (1) • Description of the chosen entrepreneur's journey. (5) • Conclusion- Identify a way forward for the entrepreneur. (1) **Assessment Criteria (Presentation):** • Organisation of slides(0.5)	1	10 7	**20**

	• Use of visual aids (1) • Responsiveness to audience (1) • Time (0.5)		3	
1.2	**Assignment I:-** During the 6th week to Describe Entrepreneurship Growth in Bhutan- How is GNH values incorporated in entrepreneurship. **For Unit I** Assessment Criteria: • Introduction (1) • Format and organization of information(1) • Content depth and accuracy (1) • Relevancy of information (1) • Conclusion(0.5) • References(0.5)	1	5	
1.3	**Assignment II:-** During the 11th week to identify the steps to form an enterprise in Bhutan(rules and regulation) and brief description about the organizations/agencies promoting entrepreneurship in Bhutan. **For Unit V** Assessment Criteria(Assignment) : • Introduction (1) • Format and organization of information(1) • Content depth and accuracy (1) • Relevancy of information (1) • Conclusion(0.5) • References(0.5)	1	5	
2	**Major Project:**			
	Business Plan(Report) prepared after Unit IV is taught. **Assessment Criteria(Report)** • Executive Summary & Company Overview • Marketing Plan • Production and Technical Plan • Manpower Plan • Organization and Management Plan • Financial Plan • Conclusion	1	**40** 3 10 10 5 10 2	**40**
	Business Plan (Presentation) during the 13th - 14th week. **Assessment Criteria(Report)** • Format of presentation materials • Professional Delivery • Business insights • Defense: Questions & Answers (Max Marks-	1	**10** 2 3 2	**10**

	8 Marks)		3	
3	**Semester End Examination**: 2 hrs duration, closed book	1	**30**	**30**

Students must obtain 40% each in the Continuous Assessment and Semester End Examination. The overall pass mark for the module is 50%.

Pre-requisites: None

Subject Matter:

Unit I: Understanding New Venture Development - *Why study entrepreneurship?*

1.1 New Venture development-: Definition & Role of an entrepreneur.
1.2 Charms of being an entrepreneur, Entrepreneurial traits
1.3 EntrepreneursVs Managers
1.4 Entrepreneurship in Bhutan: Growth and Development of entrepreneurship in Bhutan
1.5 Influence of environmental factors on New Venture Development
1.6 EDP programs-training and development of entrepreneurs
1.7 Business Ethics: concept and application

Unit II: Creativity, innovation and other soft skills

2.1 Developing creativity
2.2 Introduction to Innovation-Difference between Invention and Innovation
2.3 Negotiations; Networking and business communication; Time management

Unit-III: Business Opportunities identification and selection

3.1 Business Ideas: Idea Generation,
3.2 Sources of Business Ideas
3.3 Emerging opportunities in Bhutan: manufacturing, trading, services (including hospitality and tourism, IT, ITES-Information Technology Enabled Services and knowledge based business opportunities)
3.4 Project identification and formulation
3.5 Classification of projects
3.6 Feasibility studies in context of Bhutanese business environment.

Unit IV: Business Plan

4.1 Need and importance of Business Plan
4.2 Economic Analysis of projects: Payback period, ARR, NPV,IRR, Benefit – Cost ratio
4.3 Components of Business plan: Marketing Plan; Production & Technical Plan; Organization and Management Plan; Financial Plan.
4.4 Guide to present the Business Plan

Unit V: New venture Process & Problems-Challenges

5.1 Procedures and formalities for setting up new enterprise, Regulations governing new ventures:
5.2 Stages of new venture development, Success factors of New Venture Development
5.3 Why new ventures fail-Causes and Remedies.

Unit VI: Promoting a New Venture –Environmental Support

6.1 Business Incubators-Role of business incubation centers.
6.2 Incentives and concessions for new venture
6.3 Financial institutions supporting entrepreneurs and new venture development

Unit VII: Leadership and Growth Management

7.1 General Management: Managing a small scale business
7.2 Functional Management: Marketing, Finance and Human resource.
7.3 Entrpreneurial leadership-Building successful teams
7.4 Dimensions of Business growth and dynamics involved-different growth objectives
7.5 Different risks faced during growth stage-Strategies to avoid those risks

Reading Lists:

Essential Reading:

1. Hisrich, R.D, Perters & Michal,P.(2005) *Entrepreneurship (*5th Edition). Tata McGraw Hill.
2. Thomas & Zimmerer. *Essentials of entrepreneurship and small business management.* Prentice Hall of India.
3. Jeffry A. Timmons and Stephen Spinelli. (2004). New Venture Creation: *Entrepreneurship for the 21st Century*. McGraw-Hill/Irwin: NY
4. Ries E.(2011) *The Lean Startup: How Constant Innovation Creates Radically Successful Businesses.* Penguin United Kingdom.
5. Gupta, C.B. & Srinivasan, N.P(2014) *Entrepreneurial Development.* Sultan Chand & Sons, India.

Additional Reading:

1. Desai, V.(2005) *Dynamics of Entrepreneurial Development and management* (5th Edition). Himalaya Publishing House.
2. Mary C. (2005) *Entrepreneurship in action*(2nd Edition). Prentice Hall India.
3. Timmons, J. A and Spinelli, S. (2004). *New Venture Creation* (6th Ed.) New York. Mc-Graw Hill.
4. Hoffman R & Kidder D. (2013) *The Startup Playbook: Secrets of the Fastest-Growing Startups from Their Founding Entrepreneurs.* Chronicle Books.
5. W.Ed McMullan and Wayne A. Long. (1990).*Developing New Ventures: The entrepreneurial option*. Harcourt Brace Jovanovich,Inc: USA.
6. *Economic Development Policy of The Kingdom of Bhutan* (2010).

Date: Janaury 31, 2017

BE (Third Year) – Sixth Semester

Semester VI				Contact Hours			Marks		
							Theory		Pract
#	Code	Module	Credit	L	T	P	CA	EX	CA
1	DOS302	Design of Reinforced Concrete Structures-I	12	3	1	0	30	70	0
2	DOS303	Design of Steel Structures-II	12	3	1	0	30	70	0
3	EVE302	Environmental Engineering-I	12	3	1	0	30	70	0
4	EVS301	Environmental Science	12	4	0	0	50	50	0
5	FED303	Foundation Engineering	12	3	1	2	25	50	25
6	PRW301	Introduction to Research	12	1.5	0	0	100	0	0
Total			**72**	**16**	**4**	**2**	**265**	**310**	**25**
				22			**600**		

Module Code & Title : **DOS302 Design of Reinforced Concrete Structures- I**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Tshewang Nidup and Dr. Cheki Dorji**
Module Coordinator : **Mr. Tshewang Nidup**

General Objective:

The module introduces the fundamental engineering properties and behaviors of reinforced concrete as a structural material and principles of design of reinforced concrete members and structures. It explains the structural design process, mechanics of reinforced concrete members so that students be able to design and proportion structural concrete members for Strength, Serviceability, and Economy. The designs procedures are based on the Codal Requirements for Structural Concrete published by the relevant International standards. The principles underlying the code design provision, as well as their application to practical design problems are explained.

Learning Outcomes:

On completion of the module, learners will be able to:

1. Describe the versatility of Reinforced Concrete as an modern engineering/construction material
2. Explain the importance of the quality of constituent materials for concrete and reinforcing steel and their implication on the immediate and long term performance/behaviour of Reinforced concrete.
3. Distinguish the differences between various design philosophies, Working, Ultimate and Limit state methods of design and recognize the key concept underlying each philosophy.

4. Exhibit knowledge on the Concept of “Limit States” and the need for design for Strength, Serviceability and Economy.
5. Demonstrate the ability to draw references to the relevant codal provisions for design of Reinforced Concrete members.
6. Design safe and economical reinforced concrete members like Beams, Columns, Slabs, and Staircases using limit state method.
7. Design the RC Isolated and combined footings.
8. Design different types of RC retaining walls based on varying loading and site conditions.
9. Draw and Detail “Good for Construction” drawings of sections of reinforced concrete members

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Self-directed learning	4	60
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I – III Term Test II: in 11th week, Unit IV-VI	2	20	30
1.2	Assignment I: in 6th week, Unit II-III (Exhibit knowledge on various design philosophies, analyze and design bending sections). - Conceptual Understanding : 2 - Application of the concept : 2 - Accuracy and Correctness : 1 Assignment II: in 12th week Unit VII-VIII (Design of staircases, slabs, footings and retaining walls). - Conceptual Understanding : 2 - Application of the concept : 2 - Accuracy and Correctness : 1	2	10	
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-Requisites: TSM 203 Structural Mechanics I, TSM 304 Structural Mechanics II

Subject Matter:

Unit I: Introduction & Basic Material Properties

1.1. Introduction to Reinforced concrete Structures,

1.2. Properties of Concrete - Compressive Strength, Tensile Strength, Stress-strain curve, Modulus of elasticity, Shrinkage, Creep,
1.3. Characteristic Strength, Grades of concrete,
1.4. Design stress-strain curve.
1.5. Properties of Reinforcing steel – Types and grades, Stress-strain curve,
1.6. Specifications of concrete and reinforcing steel.

Unit II: Basic Design Philosophies

2.1 Basic concept of reinforced concrete design.
2.2 Working Stress.
2.3 Ultimate Strength Method.
2.4 Limit State Method of design.

Unit III: Analysis and Design of Sections in Bending

3.1 Flexure analysis by working stress method.
3.2 Flexure analysis by limits state methods.
3.3 Design of singly and doubly reinforced sections by Limit State Method.
3.4 T and L sections by limit state method. Detailing of beams.
3.5 Detailing of reinforcement.

Unit IV: Shear Bond and Torsion

4.1 Behavior of beams in Shear.
4.2 Design for shear Force.
4.3 Bond and Torsion.
4.4 Design of beams and slab for torsion.
4.5 Anchorage and splicing of reinforcement.

Unit V: Serviceability Conditions

5.1 Serviceability Limit States of Deflection and Cracking.
5.2 Control of Deflection and Cracking.
5.3 Calculation of Short Term Deflection.
5.4 Calculation of long term deflections.

Unit VI: Compression Members

6.1 Short and long columns.
6.2 Eccentrically loaded columns.
6.3 Interaction Diagram.
6.4 Code requirements.
6.5 Design of short columns under direct compression, Uniaxial and Biaxial loading.

Unit VII: Slabs & Staircases

7.1 Types of slabs.
7.2 Yield line theory for slabs.

7.3 Design and detailing of one way and two way slabs.
7.4 Beam and slab construction.
7.5 Design and detailing of Stair case.

Unit VIII: Footings & Retaining Structures

8.1 Types of retaining walls and dams
8.2 General design considerations and code requirements.
8.3 Analysis of base pressure on footing.
8.4 Design and detailing of isolated and combined column footings.
8.5 Lateral earth pressure on walls.
8.6 Design and detailing of cantilever and counter fort type of retaining walls.

Reading Lists:

Essential Reading

1. Park, R. &Paulay, T. (1975). Reinforced Concrete Structures. John Wiley & Sons Inc.
2. Pillai, S.U. and Menon, D. (2007). Reinforced Concrete Design (3 ed.). New Delhi: Tata McGraw Hill Publishing Company Limited.
3. Nilson, A.H. Darwin, D. and Dolan C. (2005). Design of Concrete Structures. New Delhi: Tata McGraw Hill Publishing Company Limited.
4. Sinha, S.K. (2002). Reinforced Concrete Design (2 ed.). New Delhi: Tata McGraw Hill Publishing Company Limited.
5. IS: 456-2000. Plain and Reinforced Concrete – Code of Practice (4 ed.) New Delhi: Bureau of Indian Standards

Additional Reading

1. SP-16 (1978). Design Aids for Reinforced Concrete to IS: 456-1978. New Delhi: Bureau of Indian Standards.
2. SP-34 (1978). Handbook on Concrete Reinforcement and Detailing. New Delhi: Bureau of Indian Standards.
3. Krishnaraju, N. and Pranesh, R.N. (2006). Reinforced Concrete Design. New Delhi: New Age International (P) Limited. Publishers.
4. Sinha, S.N. (2005). Reinforced Concrete Design. New Delhi: Tata McGraw Hill Publishing Company Limited.
5. Syal, I.C. and Goel, A.K. (2004). Reinforced Concrete Structures. New Delhi: S. Chand & Company Limited.

Date: Janaury 31, 2017

Module Code & Title : DOS303Design of Steel Structures-II
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mrs. Monika Thapa& Tshewang Nidup
Module Coordinator : Mrs. Monika Thapa

General Objective:

This module aims to equip students with an understanding of plastic design approaches and procedures to enable them to determine the dimensions of various steel structures (industrial structures, bridges, water tanks and towers), their components and connections. Students will also gain a practical understanding on

the erection and installation of steel structures. The module will also cover the principles underlying the code design provision, as well as their application to practical design problems. The design procedures are based on the Codal Requirements for Structural Concrete published by the relevant International Standards.

Learning Outcomes:

On completion of the module, students will be able to:

1. Compute the dead load, live load and wind load for various structures.
2. Design the moment resistant connections.
3. Design the industrial structures like steel framed buildings, gantry girders.
4. Design the bridges - plate girder bridges and truss bridges.
5. Design the steel water tanks.
6. Design the simple steel structural elements using plastic design method.
7. Distinguish different types of towers.
8. Compute the loads on the towers.
9. Design of the transmission line towers.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Independent study	4	60
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-II Term Test II: in 10th week, Unit III-IV	2	20	30
1.2	Assignment I: in 3rd week, Unit I-II (Design the industrial structures like steel framed buildings, gantry girders). – Correct determinations of wind load and other forces (1.5-marks) – Accurate approach and analysis (1.5-marks) – Proper design and sectioning of elements (2-marks) Assignment II: in 12th week, Unit V-VI (Design the simple steel structural elements using plastic design method).	2	10	

	– Accurate determination of plastic mechanics (1-mark) – Correct analysis and determination of plastic moment and collapse load (2.5-marks) – Proper design and assigning sections to the member for the determined plastic moment (1.5-marks)			
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites: TSM304 Structural Mechanics-II, DOS301 Design of Steel Structures-I.

Subject Matter:

Unit I: Building Frames

1.1 Types of structural systems and form,
1.2 Loadings types, Loading Standards
1.3 Analysis for Gravity load: Dead and Live Load
1.4 Analysis for Lateral load: Wind Load
1.5 Types of Analysis
1.6 Moment and shear forces in Members

Unit II: Steel Bridges

2.1 Types of bridges
2.2 General arrangement,
2.3 Design loads for highway bridges
2.4 Design procedure for bridges.
2.5 Analysis and Design of Truss Bridge (Influence line diagram)

Unit III: Industrial Buildings

3.1 Elements of Industrial buildings,
3.2 Portal Frames
3.3 General arrangement and stability considerations,
3.4 Design of purlins,
3.5 Design of trusses,
3.6 Design of industrial building frames, gantry girder and bracings.

Unit IV: Water Tanks

4.1. Types and design guidelines.
4.2. Design of Rectangular and Cylindrical Tanks.
4.3. Design of Staging for Water Tanks.

Unit V: Towers

5.1 Classification,
5.2 Transmission line towers,
5.3 Microwave towers,

5.4 Design loads,
5.5 Design procedure and specification.

Unit VI: Fabrication, Erection Maintenance of Steel Structures

6.1 Fabrication of simple building frames and trusses elements
6.2 Simple Steel structure erection techniques and procedure
6.3 Durability and simple maintenance procedure for steel structures

Reading Lists:

Essential Reading

1. G.L Kulak, G.Y Grondin, (2006)Limit State Design in Structural steel, 98th ed) CISC,ICCA
2. Duggal, S.K., (2010). Limit StateDesign of Steel Structures. New Delhi: Tata McGraw Hill Publishing Company Ltd.
3. Institute of Steel Development and Growth (INSDAG) Steel Design Learning Material
4. Punmia, B.C., Jain, A.K. and Jain, A.K., (2006). Comprehensive Design of SteelStructures. New Delhi: Laxmi Publications (P) Ltd.
5. Dayaratnam, P., (2008). Design of steel Structures, (2nded.). New Delhi: S.Chand &Company Ltd.

Additional Reading

1. Punmia, B.C., Jain, A.K. and Jain, A.K. (2006). Comprehensive Design of Steel Structures. New Delhi: Laxmi Publications (P) Limited.
2. Dayaratnam, P. (2008). Design of steel Structures (2 ed.). New Delhi: S. Chand & Company Limited.
3. Arya, A.S. and Ajmani J.L. (1996). Design of steel Structures (5 ed.). Roorkee: Nem Chand & Brothers.
4. Chandra, R., (1992). Design of steel Structures – Vol. II, (10thed.). New Delhi: Standard Book House.
5. Vazirani, V.N. and Ratwani, M.M., (1979). Steel Structures and Timber Structures. New Delhi: Khanna Publishers.
6. IS: 800- 2007, Code of Practice for General Construction in Steel. New Delhi: Bureau of Indian Standards
7. SP:6 (1) – 1964, Hand Book for Structural Engineers (1. Structural Steel Sections). New Delhi: Bureau of Indian Standards
8. Vazirani, V.N. and Ratwani, M.M. (1979). Steel Structures and Timber Structures. New Delhi: Khanna Publishers.
9. IS: 875 (Part-I to Part-4)-1987. Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures. New Delhi: Bureau of Indian Standards.

Date: Janaury 31, 2017

Module Code & Title : EVE302Environmental Engineering - I
Programme : BE in Civil Engineering

Credit : **12**
Module Tutor : **Dr. Cheki Dorji, Mrs. Chimi Wangmo and Mr. Ugyen Dorji**
Module Coordinator : **Mrs. Chimi Wangmo**

General Objective:

The aim of the module is to study the underlying principles of water supply systems. The module will cover aspects of water quality, treatment, design of water treatment units and distribution systems. In addition, the module will also cover the planning and preparation of water supply projects

Learning Outcomes:

On completion of the module, learners will be able:

1. Analyse inputs, outputs and functioning of urban water supply systems
2. Estimate the design population, design periods and design flows
3. Evaluate yield and development of the source and intake works.
4. Investigate physical, chemical and biological quality parameters of potable water.
5. Describe the water treatment process.
6. Determine the size of water treatment units.
7. Perform hydraulic analysis of distribution systems, pumping required for water supply systems.
8. Identify various systems of plumbing.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Written assignment	1	15
Independent study	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VI	2	20	30
1.2	Assignment I: in 6th week, Unit II-III Prepare an estimate of: The design population: 1.5 ,Design periods: 1.5 Design flows : 2 Assignment II: in 12th week, Unit V-VI Introduction : 1 Literature review: 1	2	10	

	Hydraulic analysis: 3			
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites: CHE101 Engineering Chemistry, EVE301 Hydrology

Subject Matter:

Unit I: General

1.1. Importance of water.
1.2. Role of an environmental engineer.
1.3. Historical overview of development of modern water supply system.

Unit II: Water Demand

2.1. Design population
  2.1.1 Population forecasting.
  2.1.2 Design periods & Design flows.
2.2. Factors affecting water consumption.
2.3. Variations in water demand & design capacities for various water supply components.

Unit III: Sources of Water and Collection Works

3.1. Sources of water and their characteristics
  3.1.1 Surface and groundwater sources.
  3.1.2 Selection of source
3.2. Development of source and intake works
  3.2.1 Functions and types of intakes.
  3.2.2 Selection of intakes.

Unit IV: Quality of Water

4.1 Physical characteristics- Turbidity, Solids, Temperature, Color, Taste and Odor
4.2 Chemical characteristics
  4.2.1 Inorganic minerals and salts- Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}) and Potassium (K^{+}), bicarbonate, chlorides (Cl^{-}), sulfates (SO_4^{2-}), and nitrates (NO_3^{-}), sulfates, fluorides (F^{-}), carbonates (CO_3^{2-}) and phosphates (PO_4^{3-}).
  4.2.2 Inorganic Indicators: pH, Alkalinity, Acidity, Conductivity, Hardness, Total Dissolved Solids.
  4.2.3 Organic Materials: Natural Organic Matter and Manmade organic matters.
  4.2.4 Measurement of Organic matter: Total Organic Carbon, Dissolved Gases, Biological 4.2.5 Oxygen Demand, Chemical Oxygen Demand.
4.3 Biological characteristics -Animals, Plants, Microbiological organism and water borne pathogens.
4.4 Water quality requirements and standards-National and international water quality standard.

Unit V: Treatment of Water

5.1 Overview Unit Operation and Processes in water treatment.
5.2 Primary Operations; principles, function design and drawing of screening, settling operations and coagulation.
5.3 Secondary and Tertiary Processes; principles, function design and drawing Filtration, Sand Filters, Membrane Filtration, Ultrafiltration, Ion Exchange, Precipitative Softening, Disinfection.
5.4 Other purification techniques: Activated Carbon Filtering, Reverse Osmosis, Distillation, and Desalination.
5.5 Additional treatment: Water fluoridation, removal of toxic/harmful chemicals.
5.6 Treatment plant design and preparation of hydraulic profiles.

Unit VI: Distribution of Water

6.1 Requirements of good distribution system.
6.2 Layout of distribution networks & methods of distribution.
6.3 System of supply.
6.4 Distribution reservoirs: types, storage capacity.
6.5 Design and hydraulic analysis of distribution systems.
6.6 Components, selection of pipe materials and joints, capacity and pressure requirements, pumping required for water supply systems, water supply equipment in rural area.

Unit VII: Plumbing Design

7.1 House water connections-Fixtures and fittings
7.2 Design principles of water supply in buildings.
7.3 System of plumbing, design for buildings and drawings.

Unit VIII: Planning and Preparing Water Supply Projects

8.1 Data collection and analysis.
8.2 Project formulation, drawings and estimates.
8.3 Project reports.

Reading Lists:

Essential Reading

1. Garg, S. K. (2005). Water Supply Engineering: Environmental Engineering (4 ed.).New Delhi: Khanna Publisher.
2. Peavy, H.S., Rowe, D.R., & Tchobanoglous, G. (1985). Environmental Engineering. New Delhi: Tata McGraw Hill.
3. World Health Organisation. (1997). Water Pollution Control. United Nations Environment Programme.
4. Sawyer, C.N., McCarty, P.L. & Parkin, G.F. (1994). Chemistry for Environmental Engineering (4 ed.). New York: McGraw Hill.
5. Reynolds, T.D. & Richards, P.A. (1996). Unit Operation and Processes in Environmental Engineering (2 ed.). Boston: PWS Publishing Company

Additional Reading

1. Hammer, M.J. (2006).Water and Wastewater Technology (4 ed.). New Delhi: Prentice Hall.
2. Viessman, W. and Hammer, M. J. (2005). Water Supply and Pollution Control. New Delhi: Pearson Edition.

Date: Janaury 31, 2017

Module Code and Title **:** EVS301 Environmental Science
Programme **:** BE in Civil Engineering
Credit **:** 12
Module Tutors **:** Mr. Basant Pradhan & Mr. Bharat K Humagai
Module Coordinator : Mr. Bharat K Humagai

General Objective:

The module aims to introduce the concepts of environment and associated issues such as poverty, disaster risk reduction and gender. It dwells on the key emerging environmental pressures in the country and the corresponding adaptation measures in response to the pressure. Mainstreaming of cross cutting issues (environment, climate change, poverty, disaster and gender) into policies and plans and mainstreaming tools such as SEA and EIA are also introduced.

Learning outcomes:

On completion of the module, students will be able to:

1. Explain man-environment relationship and emerging sustainability problems/issues.
2. Prepare a range of innovative and proactive adaptation and disaster resilient measures to respond to climate change.
3. Suggest remedial measures to overcome environmental pressures.
4. Explain Environmental Impact Assessment (EIA).
5. Describe the concept of Strategic Environmental Impact Assessment
6. Evaluate Risk Assessment on disaster risk reduction.
7. Describe mainstreaming of Environment, Climate change and Poverty.
8. Explain the framework to mainstream Environment, Climate Change and Poverty (ECP)

Learning and Teaching Approach:

Approach	**Hours per Week**	**Total Credit Hours**
Lecture	3	45
Case study/Presentation/Group activities	1	15
Independent study/self-directed learning	4	60
Total		120

Assessment Approach:

Sl. No.	*Mode of Assessment*	*Nos.*	*Marks Allocated*	*Marks (%)*
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-II Term Test II: in 10th week, Unit III-IV	2	30	50
1.2	Assignment I: in 2nd week, Unit II (Identifying the remedial measures to overcome the current environmental pressures). Assignment II: in 7th week (Introduction to natural, climate induced and manmade disasters such as floods, forest fires, windstorm, earthquake, Glacial Lake Outbreak Flood (GLOF). • Introduction. • Content approach. • Content depth and accuracy. • Use of scientific data. • Case study. • Conclusion. • References.	2	10 0.5 0.5 1 1 1 0.5 0.5	
1.3	Presentation & case study: in 2nd week (Energy, land degradation, pollution, air, water, soil, forest and mineral resources relating to state, pressures and response strategies). Assessment criteria (Presentation) • Organisation. • Style. • Pace. • Content depth. • Content accuracy. • Use of visual aids. • Responsiveness to audience. • Time.	1	10 2 1 1 1 2 1 1 1	
2	Semester End Examination: 3 hours, closed book.	1	50	50

Pre-requisite: None

Subject Matter:

Unit I: Introduction to Environment and other Crosscutting issues.

1.1 Introduction to environment: Concepts, scope and importance and sustainability.
1.2 Human-environment-development relationship: construing environment as opportunity and means of livelihood particularly for the poor.
1.3 Concepts of Environmental governance, Environment in GNH and five-year plans and Sustainable development.

Unit II: Emerging Environmental Issues and interventions to address them

2.1 Climate Change
2.2 Brief introduction to Climate change and national and international commitments (for example carbon neutrality) to climate change.
2.3 Causes of climate change, both natural and anthropogenic.
2.4 Impact of climate change in general and in Bhutanese context
2.5 International obligation for Adaptation and adaptation measures initiated in Bhutan (*Experience sharingon the National Adaptation Plan of Action and other successful adaptation interventions)* and elsewhere.
2.6 Greenhouse emission and policy measures to reduce greenhouse gas emission.
2.7 Introduction to waste, different types of waste and impacts: municipal waste, industrial waste, e-wastes and hazardous waste.
2.8 Integrated Solid Waste Management and using solid waste as resource
2.9 Solid Waste Management Act.
2.10 Land degradation: Causes (Urbanization, agricultural practices, change in land use pattern, developmental activities), impacts, adaptation and mitigation.
2.11 Air, Forest and Mineral resources: State, Pressures and Response strategies.
2.12 Pollution Issues: Noise, Thermal Pollution: causes, impacts and adaptive and interventions

Unit III: Disaster Risk Reduction and Management Approaches

3.1 Introduction to natural, climate induced and manmade disasters such as floods, forest fires, windstorm, earthquake, Glacial Lake Outbreak Flood (GLOF).
3.2 Causes and impacts of disasters.
3.3 Disaster Risk Analysis/ Risk Assessment and Disaster Risk Reduction
3.4 Innovative and proactive measures, including non-structural mitigation measures (falling hazards) initiated in Bhutan and beyond in managing and reducing the risk of disaster.

Unit IV: Environmental Impact Assessment (EIA)

4.1 Principles and theoretical background of Environmental Impact Assessment (EIA), including social impact assessment (SIA).
4.2 Introduction to SEA, Difference between SEA and EIA, Rationale and importance/benefit of SEA, Challenges of conducting SEA, limitation and emerging criticism on SEA.

Unit V: Mainstreaming of cross cutting issue (ECP, DRR and Gender) into development policies, plan and programs

5.1 Concepts of mainstreaming, approaches and tools for mainstreaming, challenges.
5.2 Mainstreaming of ECPM into Development policies, plans and programmes in Bhutan.

Reading Lists:

Essential Reading

1. Canter, L.W. (1996). *Environmental Impact Assessment*. Singapore: McGraw-Hill, Inc.
2. Davis, H.L., & Masten, S.J. (2004). *Principles of Environmental Engineering &*

Sciences. New York, NY: McGraw Hill
3. Masters, G.M. (1991). *Introduction to Environmental Engineering and Science*, New Delhi: Prentice-Hall India Pvt. Ltd.
4. Nebel, B. J., (1987).*Environmental Science*, Prentice-Hall Inc.
5. Therivel, R. (2004). *Strategic Environmental Assessment in Action.* London: Earthsca

Additional Reading

1. Clayton, B.D., & Bass, S. (2009). *The challenges of environmental mainstreaming: Experience ofintegrating environment into development institutions and decisions.* London: EnvironmentalGovernance No.3. International Institute for Environment and Development.
2. Clayton, B.D., & Sadler, B. (2005). *Strategic Environmental Assessment: A sourcebook andreference guide to international experience.* London: Earthscan.
3. Wright, R.T., & Nebel, B.J. (2002). *Environmental Science: Towards a Sustainable Future.*
6. Cunningham, W.P., & Cunningham, M. A. (2007). Principles of Environmental Science: Inquiry & Application (4 ed.) New Delhi: McGraw Hill Inc.
7. P Wathern, Unwin Hyman (1988). *Environmental Impact Assessment*: Theory and Practice, London.

Date: Janaury 31, 2017

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3 Module Code & Title : FED303 Foundation Engineering

Programme : BE in Civil Engineering
Credit :12
Module Tutor : Mr.Karma Tempa & Tshering Cheki
Module Coordinator : Mr.Karma Tempa

General Objective:

The module aims to provide foundation engineering concepts on earth pressure and retaining structures. Other topics such as stability of slopes, foundations, shallow foundations, pile foundation and well foundations will be covered. Emphasis on principles of machine foundation, soil exploration and its ground improvement techniques including applications for civil engineering works are focused.

Learning Outcomes:

On completion of the module, students will be able to:

1. Compute earth pressure at rest, passive earth pressure and active earth pressure for analysing lateral total thrust acting on retaining wall.
2. Design retaining walls based on total active thrust and check stability against tension, sliding and overturning.

3. Analyze the stability of slopes with different methods for infinite and finite slopes.
4. Select appropriate foundation according to the field investigations and conditions.
5. Design various types of foundation including machine foundations.
6. Perform different tests for soil exploration and their analysis of test data.
7. InterpretF geotechnical reports.
8. Explain different ground improvement technique required for different soil condition.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Practical	2	30
Tutorial	1	15
Independent study/self-directed learning	2	30
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VI	2	20	25
1.2	**Assignment I:** in 6th week, Unit I-III (Solve the geotechnical related problems such as Identification of types of foundation needed) a. Approach and method b. Content c. Illustration of drawings and free body diagrams **Assignment II:** in 12th week, Unit IV-VIII (Assessment of stability of foundation, slope stability analysis, application of well foundation and application of types of machine foundations). a. Approach and method b. Content c. Illustration of drawings and free body diagrams	2	1 3 1	
2	Continuous Assessment (Practical)			

2.1	Regular assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).	1	15 1.5 4.5 3 3 3	25
2.2	Practical examination/Viva-voce/Quiz:		10	
3	Semester End Examination: 3 hours, closed book.	1	50	50

Pre-requisites: FED302 Soil Mechanics

Subject Matter:

Unit I: Earth Pressure and Retaining Structures

1.1. Earth pressure at rest, active and passive earth pressure computation using Rankine's & Coulomb's earth pressure theories.
1.2. Computation of active and passive earth pressure for c-φ soil by Bell's theory.
1.3. Culmann's Graphical method of earth pressure.
1.4. Stability analysis of retaining wall.

Unit II: Stability of Slopes

2.1 Embankment slope: Road and earth dam embankments, Hill slopes, Modes of failure and usual protective measures.
2.2 Stability analysis: Infinite slopes and concept of factor of safety, Friction circle method, Method of slices, Bishop's simplified method, Taylor's stability number and stability curves, Acceptable values of factor of safety.

Unit III: Foundations

3.1 Common types of foundations with examples.
3.2 Illustration of situations where each one of them is adopted with Basis for design.

Unit IV: Shallow Foundations

4.1 Types and their selection, Terminology.

4.2 Bearing capacity: Terzaghi's Equation, Meyerhof's and Hansen's equations Computation of bearing capacity of shallow foundation in cohesion less and cohesive soil, Effects of various factors on bearing capacity, Use of field test data to determine the bearing capacity of soil.

4.3 Settlement: Component of settlement, Limits of settlement, Estimation of settlement of footings on sand using penetration and load test data, Proportioning of footings.

Unit V: Pile Foundation

5.1 Situations where adopted, Types of piles.

5.2 Outlines of steps involved in proportioning.

5.3 Bearing capacity and settlement of single and group of piles, proportioning with field/lab data as input.

Unit VI: Well Foundations

6.1 Situations where adopted.

6.2 Elements of wells.

6.3 Types of wells.

6.4 Methods of construction.

6.5 Tilt and shift, Remedial measures, Proportioning: Depth and size of wells on the basis of scour depth, bearing capacity & settlement.

Unit VII: Introduction to Machine Foundation

7.1. Types of machines and their foundations.

7.2. Terminology, Free and forced un-damped vibration.

7.3. Free and forced damped vibration, Design criteria, Field methods of determining design parameters - Cyclic plate load test, Block vibration test.

Unit VIII: Soil Exploration

8.1 Purpose of soil exploration, Boring, Sampling, Standard penetration test, static and
dynamic cone penetration tests.

8.2 Co-relations between penetration resistance and shear strength parameters, plate load test.

8.3 Planning of soil investigation, number of bore holes and depth of exploration, types of tests to suit soil conditions.

Unit IX: Ground Improvement Techniques

9.1. Physical and Chemical methods of ground improvement.

List of Practicals:

1. Consolidation Test.
2. Triaxial Test.
3. Demonstration of Plate Load Test.
4. Boring, Sampling for Soil Investigations.
5. Standard Penetration Test.
6. Block Vibration Test.
7. Static and Dynamic Cone Tests.

Reading Lists:

Essential Reading

1. Gopal. R., and Rao, A. S. R. (2014). Basic and AppliedSoilMechanics (2 ed.). New Delhi: New Age International Publisher.
2. Punmia, B.C. (2009). Soil Mechanics & Foundation (4 ed.). New Delhi: Laxmi Publication.
3. Murthy. V.N.S. (2002). Principles of SoilMechanics and Foundation Engineering (3 ed.). New Delhi: UBS Publishers Distributors.
4. Murty, V. N. S. (2009). Soil Mechanics and Foundation Engineering: Geotechnical Engineering Series (2 ed.). New Delhi: CBS Publishers.
5. Arora, K. R. (2009). Soil Mechanics and Foundation Engineering: Geotechnical Engineering(3 ed.). New Delhi: Standard Publishers.

Additional Reading

1. Bharat. S. and Shamsher. P. (1976). SoilMechanics and Foundation Engineering.Roorkee: Nem Chand and Bros.
2. Mittal. S. (2008). Soil Testing for Engineers. New Delhi: Khanna Publication.
3. Coduto. D.P. (2006). GeotechnicalEngineering (2 ed.). New Delhi: Prentice-Hall.
4. Kramer. S. L. (2006). Geotechnical Earthquake Engineering (2 ed.). New Delhi: Pearson Edition.
5. Alam,S. (2004). Modern GeotechnicalEngineering (2 ed.). New Delhi: CBS Publishers.
6. Alam, S. (2004). Basic Soilmechanics andFoundations. New Delhi: CBS Publishers.
7. Gulhati. S. K and Datta. M. (2006). GeotechnicalEngineering (2 ed.). New Delhi: Tata McGraw Hill.
8. Holtz, R. & Kovacs, W.D. (1981). Introduction to Geotechnical Engineering. New York: John Wiley and Sons.
9. Lambe. T.W. and Whitman, R.V. (1969). Soil Mechanics. New York: John Wiley & Sons.
10. Kazimi, S. M. A.(2003). SoilMechanics (2 ed.). New Delhi: Tata McGraw Hill.
11. Kaniraj. S.R. (2008). Design Aids in SoilMechanics and Foundation Engineering (2 ed.). New Delhi: Tata McGraw Hill.
12. Terzaghi. K. & Peck. R.B. (1968). Soil Mechanics in Engineering Practice. New York: John Wiley and Sons.

Date: Janaury 31, 2017

Module Code and Title : **PRW301 Introduction to Research**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor :**Tsheten Dorji, DRIL**

General Objective:

This module aims to provide students with an understanding of research principles, a range of research methodologies and appropriate analysis tools. It will also develop in the students the skills and knowledge necessary to undertake an independent project. Students will take up a small scale research project that will enable them to go through the whole research process to better understand the theory learned and to equip them with the practical skills and knowledge required to undertake their project work in a later semester of the programme.

Learning outcomes:

On completion of the module, students will be able to:

1. Develop an achievable set of research / major project aims and objectives
2. Analyse the characteristics of different methodological approaches and methods of research.
3. Evaluate the applicability of different research methods within their own study area.
4. Develop a ` and justify the selection of the chosen research method(s).
5. Justify the selection of appropriate data analysis methods.
6. Produce a clear, coherent and well-presented proposal.
7. Write scientific report on a small research conducted.

Learning and Teaching Approach:

The subject matter of the module will be taught to the students and will be covered in 20 hours during the first 2 weeks of the semester. After theory input is covered, a tutor will be assigned as a guide for a group of students (3-4). Most of the learning will take place by students carrying out the basic research steps. Students will identify a research topic at the beginning of the semester in consultation with the guide. The topic should be finalized by the 3rd week of the semester. Once the topic is identified, students will research on the topic in consultation with the guide. At the end of the 5th week, students will present their proposal to a committee comprising of at least 3 tutors identified by the programme leader. At the end of 12th week students will be required to produce a 3000 word scientific report on the research conducted with simple and small scope.

Approach	Hours per Week	Total Credit Hours
Lecture	1.5	20
Self-directed learning	7	100
Total		120

At the end of the 12th week, students will have to submit printed copy of the research report and also present to the same committee.

Timeline of research:

Sl.	Activities	Due date (week)

No.		
1	Grouping of students	1st week
2	Finalization of topic	3rd week
3	Proposal presentation	5th week
4	1st review by guide	8th week
5	2nd review by guide	10th week
6	Final report submission	12th week
7	Report presentation	14th week

Assessment Approach:

The module will be assessed in four parts as shown below. Out of a total of 100 marks, 20 marks for proposal presentation, 30 marks for continuous assessment by guide, 20 marks for report presentation and 30 marks for submitting scientific report. The detail marking scheme is shown below.

Sl. No.	Mode of Assessment	Marks Allocated
1	Proposal Presentation	20
2	Continuous assessment by guide.	30
3	Report presentation	20
4	Submission of scientific report	30

Presentation	Marks allocated
Presentation Techniques	3
Content	6
Response to the Questions	8
Language (Verbal clarity) and confidence	3

Proposal evaluation	20
Aim and objectives	4
Methodology	8
Expected outcome	2
Feasibility	2
Originality and practicality	2
Work plan	2

The continuous assessment by guide will be based on sections like (i) Introduction, (ii) Problem statement with aim and objectives, (iii) methods, (iv) literature review, (v) results, (vi) discussion with conclusions. Students are expected to submit each section every week and the guide will award marks for every section independently.

Report Evaluation	30
Abstract	1.5
Introduction	1.5
Literature review	4.5
Technical content	7.5
Results	7.5
Originality	3.0
Practicality	3.0

Conclusion	1.5

Pre-requisites: None

Subject Matter:

Unit I: Introduction

1.1 Research theory analysis
1.2 Principles and practice of research
1.3 Research process
1.4 Research proposal
1.5 Research paper
1.6 Designing a research or project strategy

Unit II: Proposal writing

2.1 Processes
2.2 Component of proposal
2.3 Administrative procedures
2.4 Technical check lists
2.5 Assurances and certification

Unit III: Research Methodologies

3.1 Overview of various methodologies,
3.2 Comparisons between different modes of investigation
3.3 Appropriateness of various methodological approaches to research
3.4 Developing the research question
3.5 Developing aims and objectives

Unit IV: Literature Review

4.1 The purpose and production of a literature review
4.2 Review of literature
4.3 Searching strategy
4.4 Review processes
4.5 Compiling a research bibliography.
4.6 Review of ethical, legal and political issues.

Unit V: Data &Analysis

5.1 Sampling types and authentication
5.2 Data collection techniques
5.3 Methods of data analysis
5.4 Evaluation of analysis tools
5.5 Interpreting the results of data analysis
5.6 Presentation and Interpretation of result

Unit VI Referencing system

6.1 Type of referencing and citation
6.2 Referencing and citation system
6.3 Table, Figure and formula citation

Unit VII Report and publication

7.1 Accurate documentation
7.2 Abstract, introduction, methods, literature review, result discussion and conclusion.
7.3 Publication process

Reading Lists:

Essential Reading

1. Balnaves, M., &Caputi, P. (2001). Introduction to Quantitative Research Methods: An investigative approach. London: Sage Publications Ltd.
2. Hart, C. (1998). Doing a Literature Review. London: Sage Publications Ltd.
3. Ruane, J. M. (2005). Essentials of Research Methods: A Guide to Social Science Research. London: Wiley-Blackwell Publishing.
4. Punch, K. F. (2006). Developing Effective Research Proposals (Essential Resource Books for Social Research) (2 ed.). London: Sage Publications Ltd.
5. Plowright, D. (2011). Using Mixed Methods: frameworks for an integrated Methodology. London:Sage Publications Ltd.

Additional Reading

1. Yin, R. (2009). Case Study Research: Design and Methods (4 ed.). London: Sage Publications Ltd.
2. Fellows, Richard F. and Liu, Anita M. M. (2015). Research Methods for Construction (3 ed.). London: Wiley Blackwill Company.

Date: Janaury 31, 2017

BE (Fourth Year) – Seventh Semester

Semester VII				Contact Hours			Marks		
							Theory		Pract
#	Code	Module	Credit	L	T	P	CA	EX	CA
1	DOS404	Design of Reinforced Concrete Structures-II	12	3	1	0	30	70	0
2	FMH403	Hydraulics Structures & Water Power Engineering	12	3	1	0	30	70	0
3	EVE403	Environmental Engineering-II	12	3	1	2	25	50	25
4	BPD403	Estimating Costing and Tendering	12	3	2	0	50	50	0
5	HWE401	Highway Engineering	12	3	1	2	25	50	25
6	PRW403	Project Work	0	0	0	2	0	0	0
		Total		**15**	**6**	**6**	**160**	**290**	**50**
			60	**27**			**500**		

Module Code & Title : DOS404 Design of Reinforced Concrete Structures-II
Programme : BE in Civil Engineering
Credit : 12

Module Tutor : Mr. Tshewang Nidup & Monika Thapa
Module Coordinator : Mr. Tshewang Nidup

General Objective:

This module introduces the students to the concepts of analysis and design of building frames, Pre stressed concrete members, Liquid Retaining structures and continuous and curved beams. The module also explains key behavioral nature of reinforced concrete members like creep and shrinkage. Concepts and the application of the moment redistribution and ductility in the design of the reinforced concrete structures are also introduced.

Learning Outcomes:

On completion of the module, students will be able to:
1. Explain the principles of prestressed concrete, prestressing systems and the methods of prestressing.
2. Calculate the losses in prestressed concrete members
3. Explain the philosophy of design and design prestressed concrete elements.
4. Design the continuous and curved beams using limit state method.
5. Determine the effects of shrinkage and creep on the ultimate stress and strain level in concrete members.
6. Analyze building frames for gravity and lateral loads and design key elements
7. Design different types of reinforced concrete water tanks including their foundations.
8. Illustrate the concept of moment redistribution and ductility of reinforced concrete members.
9. Design RC bridge components for different loading conditions.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Independent study	4	60
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VI	2	20	30
1.2	Assignment I: in 4th week, Unit II-III (Design curved beam using Limit State Method) - Conceptual Understanding : 2 - Application of the Concept : 2 - Accuracy and correctness : 1 Assignment II: in 8th week, Unit V-VI	2	10	

	(Design reinforced concrete water tanks and prestressed concrete elements). - Conceptual Understanding : 2 - Application of the Concept : 2 - Accuracy and correctness : 1			
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites:TSM101 Engineering Mechanics, TSM202 Strength of Materials, TSM203 Structural Mechanics-I and II, DOS301 Design of Reinforced Concrete Structures-I

Subject Matter:

Unit I: Building Frames

1.1 Introduction Structural Systems for building frames
1.2 Codal Specification and Loading standards on building frames,
1.3 Analysis for Vertical loads,
1.4 Analysis of frames subjected to Horizontal forces , Approximate methods, Portal Method, Cantilever methods
1.5 P – Δ Effect in Tall and slender frames.

Unit II: Continuous and Curved Beams

2.1 Analysis and Design of continuous reinforced concrete beam
2.2 Design of beams curved in plan.

Unit III: Moment Redistribution and Ductility

3.1 Moment Redistribution Concept,
3.2 Moment redistribution in RC members,
3.3 Ductile Behaviour, Importance of ductility,
3.4 Factors Affecting Ductility in Reinforced concrete member
3.5 Analysis for Ductility, Ductility Factor
3.6 Ductile detailing of RC members

Unit IV: Shrinkage and Creep in Concrete

4.1 Introduction to Creep and Shrinkage
4.2 Shrinkage and creep strain in concrete.
4.3 Effect of shrinkage on Stress and Strain in Reinforced concrete beam and columns.
4.4 Effects of creep on stresses in Reinforced Concrete Columns and beams.

Unit V: Water Tanks

5.1 Introduction to Liquid retaining Structures
5.2 Design of rectangular water tanks
5.3 Design of Circular Water Tanks (Flexible Base and Rigid base)

5.4 Concepts and design of underground tanks

5.5 Concept of elevated water tanks

5.6 Introduction of basic concepts of staging and foundations for elevated water tanks

5.7 Basic design features of Intze tanks

Unit VI: Pre-Stressed Concrete

6.1 Basic concepts.
6.2 Prestressing systems and methods.
6.3 Material properties.
6.4 Losses of pre stress.
6.5 Merits and demerits of prestressed concrete.
6.6 I.S. Specifications (IS:1343-2000).
6.7 Analysis and design of sections for flexure and shear.

Unit VII: Introduction to Reinforced Concrete Bridge

7.1 Introduction to bridge – Types of Bridges

7.2 Factors affecting the selection of the bridges

7.3 The economic impact of span and number of bridge pier

7.4 Loading standards for bridges

7.5 Design of a RC deck slab bridge Reading Lists:

Reading List:

Essential Reading

1. Park, R. &Paulay, T, (1975). Reinforced Concrete Structures. John Wiley & Sons Inc
2. Pillai, S.U. and Menon, D., (2007). Reinforced Concrete Design (3rd ed.). New Delhi: Tata McGraw Hill Publishing Company Ltd.
3. Raju, N.K., (2007). Prestressed Concrete, (4th ed.). New Delhi: Tata McGraw Hill Publishing Company Ltd.
4. Lin, T.Y. and Burns, N.H., (2004). Design of Prestressed Concrete Structures (3rd ed.). Singapore: John Wiley & Sons (Asia)
5. Punmia, B.C., Jain, A.K. and Jain, A.K., (2008). Limit State Design of Reinforced Concrete (As per IS:456-2000). New Delhi: Laxmi Publications (P) Ltd.
6. Raina, Concrete for Construction : facts and Practice
7. Ashok. K Jain(2012). Reinforced Concrete: Limit State Design. Nem Chand & Bros.; ISBN-10: 8185240663.ISBN-13: 978-8185240664.ASIN: B008YECAZC. (7 ed.).

Additional Reading

1. Victor, D.J., (2001). Essentials of Bridge Engineering (4 ed.). New Delhi: Oxford & IBH Publishing Co. Private Limited.
2. Punmia, B.C., and Jain, A.K. (2006). R.C.C Designs (Reinforced Concrete Structures). New Delhi: Laxmi Publications (P) Limited.
3. Punmia, B.C., and Jain, A.K. (2008). Limit State Design of Reinforced Concrete (As per IS: 456-2000). New Delhi: Laxmi Publications (P) Limited.

4. Syal, I.C. and Goel, A.K. (2004). Reinforced Concrete Structures (6 ed.). New Delhi: S. Chand & Company Limited.
5. Nilson, A.H., Darwin, D. and Dolan, C.W. (2008). Design of Concrete Structures. New Delhi: Tata McGraw Hill Publishing Company Limited.
6. Rakshit, K.S. (2004). Design and Construction of Highway Bridges. Kolkata: New Central Book Agency (P) Limited.
7. IS: 456-2000. Plain and Reinforced Concrete – Code of Practice (4 ed.). New Delhi: Bureau of Indian Standards.
8. IS: 875-1987. Code of Practice for Design Loads (Other than Earthquakes) for Buildings and Structures. New Delhi: Bureau of Indian Standards.
9. IS: 1343-2012. Code of Practice for Prestressed Concrete. New Delhi: Bureau of Indian Standards.
10. IS: 3370-2009 (Part I-IV). Code of Practice for Concrete Structures for the Storage of Liquids. New Delhi: Bureau of Indian Standards.
11. SP-34: 1987. Handbook on Concrete Reinforcement and Detailing. New Delhi: Bureau of Indian Standards.
12. IS13920: 1993. Ductile Detailing of Reinforced Concrete Structures. New Delhi: Bureau of Indian Standards.
13. IRC Code Series.

Date: Janaury 31, 2017

4

5 Module Code & Title : FMH403 Hydraulic Structures & Water Power Engineering

Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mrs. Chimi Wangmo and Mr. Leki Dorji**
Module Coordinator : **Mr. Leki Dorji**

General Objective:

The module aims to introduce the principles of design and applications of various hydraulics structures. In addition, it will cover the concepts of water power engineering and energy solutions.

Learning Outcomes:

On completion of the module, students will be able to:
1. Evaluate the effect of sedimentation on the life of water retaining structures and select appropriate control measure.
2. Estimate reservoir capacity.
3. Carry out stability analysis of various types of dams.
4. Design the most appropriate type of spillways for a dam.
5. Identify the types of hydraulic jump and energy dissipaters.
6. Select and design cross drainage works for given conditions.
7. Carry out assessment of size and layout hydropower components.
8. Evaluate hydropower potential.
9. Identify types of irrigation canal systems.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Written assignment	2	30
Independent study	2	30
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test-II: in 10th week, Unit IV-VI	2	20	30
1.3	Assignment I: in 4th week, Unit I-III (Evaluate the effect of sedimentation on the life of water retaining structures and select appropriate control measures). • Introduction • Methods/steps/procedure • Conclusion Assignment II: in 8th week, Unit IV-VII(Select and design cross drainage works for given conditions and carry out assessment of size and layout hydropower components). • Introduction • Methods/steps/procedure • Conclusion	2	(10) 1.5 2.0 1.5 1.5 2.0 1.5	
2	Semester End Examination: 3 hours, closed book	1	70	70

Pre-requisites:FMH201 Fluid Mechanics, FMH202 Hydraulics

Subject Matter:

Unit I: Introduction

5.1 Sources and forms of energy.
5.2 Types of power plants.
5.3 Elements of hydropower scheme.
5.4 Hydropower development in Bhutan.
5.5 Powerhouse structures-substructure and superstructure, layout and dimensions.

Unit II: Hydropower Plant Classification

6.1 Surface and underground power stations
6.2 Low, medium and high head plants
6.3 Pumped storage plants, tidal power plants, Micro plants

Unit III: Load and Power Studies

7.1 Estimation of hydropower potential.
7.2 Firm and secondary power-Storage and Pondage.
7.3 Flow duration curves-Power duration curves and load duration curves.
7.4 Load factor, capacity factor, Utilization factors.

Unit IV: Reservoir and Dam Planning

1.1 Selection of site for a reservoir.
1.2 Classification of reservoir.
1.3 Storage zones of reservoir.
1.4 Design capacity of reservoirs.
1.5 Trap efficiency, reservoir sedimentation, life of a reservoir.
1.6 Reservoir losses.
1.7 Dams, preliminary investigation- selection of dam site.
1.8 Classification of dams.
1.9 Selection of type of dam.

Unit V: Spillways

3.1 Types of spillways.
3.2 Design of Ogee spillway.
3.3 Principles of shaft, side channel, chute and syphon spillways.
3.4 Principles of energy dissipater.
3.5 Indian standard criteria for design of hydraulic jump.
3.6 Stilling basins.
3.7 Bucket type dissipater gates.

Unit VI: Cross Drainage Structures

4.1 Necessity of cross-drainage structures.
4.2 Types and selection-Comparative merits and demerits.
4.3 Design of various types of cross-drainage structures-aqueduct, syphon aqueducts, super passage, syphon, level crossing and other types.

Unit VII: Water Conveyance

8.1 Intake, Penstocks.
8.2 Economical diameter of Penstocks.
8.3 Anchor blocks, Values.
8.4 Basic principles of water hammer-Surge tanks, functions and types.

Unit VIII: Canal Irrigation and Distribution of Canal Water

9.1 Types of irrigation system, techniques of water distribution in farms.
9.2 Types of canals, canal alignment, parts of a canal irrigation system, assessment of water requirements.
9.3 Estimation of channel losses, design of channels- regime and semi-theoretical approaches. Types of channel linings and design of lined and unlined channel.
9.4 Shield's Entrainment Method, Kennedy's Theory, Lacey's Theory, silt control in canals.

9.5 Systems of regulation and control- intensive & extensive irrigation outlets-types, essential requirements.
9.6 Flexibility, proportionality, sensitivity, sensitiveness & efficiency, assessment of canal revenue, fixation of canal charges, operation and maintenance charges.

Unit IX: Concept of River training works

10.1 Channel linings.
10.2 Bank Protections.
10.3 Application of Weirs in river training works
10.4 Groynes.

Reading Lists:

Essential Reading

1. Garg, S. K. (2003). Irrigation Engineering & Hydraulic Structures. New Delhi: Khanna Publishers.
2. Modi, P.N. (1994). Irrigation Water Resources and Water Power Engineering. New Delhi: Standard Book Company.
3. Dandekar, M.M. and Sharma, K.N. (1994). Water Power Engineering. New Delhi: Vikas Publishing Company.
4. Deshmukh M.M. (1978). Water Power Engineering. New Delhi: DhanpatRai& Sons.
5. Asawa, G.L. (2003). Irrigation Engineering. New Delhi: New Age International Publishers.

Additional Reading

1. Singh, Gulchoursan. (1980). Irrigation Engineering. New Delhi: Standard Book House.
2. Sharma, S. K. Design of Irrigation Structures. S Chand & Company.
3. Varshney, R.S., Gupta, S.C., Gupta, R.L. (1988.) Theory and Design of Irrigation Structures. Roorkee: Nem Chand & Bros.
4. Singh, Bharat. (1988). Fundamentals of Irrigation Engineering. Roorkee: Nem Chand & Bros.
5. Punmia, B.C &Pande, B.B. (1990). Irrigation and Waterpower Engineering.New Delhi: Standard Publisher and Distribution.
6. Bhattacharya, P.K. (1998).Waterpower Engineering. New Delhi: Vikas Publications.
7. Barrows, H.K. (1934). Water Power Engineering (2 ed.). New York: McGraw Hill Publishing Company.
8. Jog, M.G. (1989). Hydro-Electric & Pumped Storage Plants. New Delhi: Wiley Eastern Limited.
9. Murty C., Satyanarayana. (1977). Water Resources Engineering -Principles & Practice. New Delhi: New Age International Publishers.

Date: Janaury 31, 2017

Module Code & Title : **EVE403 Environmental Engineering-II**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Dr. Cheki Dorji, Mrs. Chimi Wangmo and Mr. Ugyen Dorji**
Module Coordinator : **Mrs. Chimi Wangmo**

General Objective:

The aim of the module is to study sanitation, design and working principles of wastewater treatment units. It will also include the management of industrial and solid waste.

Learning Outcomes:

On completion of the module, students will be able:
1. Analyse inputs, outputs and functioning of urban drainage systems.
2. Estimate the quantity of domestic sewage and storm water.
3. Examine importance of wastewater characteristics in treatment process selection.
4. Describe waste water treatment process.
5. Determine the size of wastewater treatment systems for preliminary, primary and secondary treatment.
6. Identify different methods of disposal of sewage.
7. Appraise the significance of separate treatment of industrial waste.
8. Determine types of solid waste and procedures adopted for their disposal.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Practical	2	30
Tutorial	1	15
Written assignment	1	15
Independent study	1	15
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VI	2	20	30
1.2	Assignment I: in 6th week, Unit II-III (Examine importance of wastewater characteristics in treatment process selection. Clarity: 1.0 Depth: 1.0 Currency:1.0 Originality: 1.0 Referencing: 1.0	2	10	

	Assignment II: in 12th week, Unit IV (Describe waste water treatment process and Determine the size of wastewater treatment systems). Clarity: 1.0 Depth: 1.0 Currency:1.0 Originality: 1.0 Referencing: 1.0			
2	Continuous Assessment (Practical)			
2.1	Regular assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).	1	15 1.5 4.5 3 3 3	
2.2	Practical examination/Viva-voce/Quiz:		10	
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites: EVE302 Environmental Engineering-I

Subject Matter:

Unit I: General

1.1 Systems of Sanitation.
1.2 Types of sewage and sewerage system.
1.3 Component of sewerage system.
1.4 Role of an Environmental Engineer.
1.5 Historical overview of development of sewage treatment.

Unit II: Sewage Characteristics

2.1 Physical characteristics - Turbidity, Solids, Temperature, Color, Taste and Odor
2.2 Chemical characteristics

2.2.1 Inorganic Materials & metals: Hg, Pb, Cd, Cr, Cu, Ni, acids and bases.
2.2.2 Organic materials- biodegradable organic matter, Detergents, pesticides, fat, oil and grease, color, solvents, phenols, cyanide.
2.2.3 Nutrients; Nitrogen, phosphorus, ammonium.
2.3 Computation and application of BOD and COD.
2.4 Pathogenic microorganisms- E.coli, Coliforms, worms.

Unit III: Collection of Sewage

3.1 Quantity of sewage and variations.
3.2 Quantity of storm water- rational methods.
3.3 Shapes of sewer.
3.4 Hydraulic design of sewers.
3.5 Construction and testing of sewer lines.
3.6 Sewer materials, joints and appurtenances.
3.7 Sewage pumping and pumping stations.
3.8 Maintenance of sewerage system.

Unit IV: Treatment of Sewage

4.1 Classification of treatment operation and processes.
4.2 Preliminary and Primary treatment units- screening, grit removal, oil and grease removal, flow equalization, sedimentation, sedimentation with coagulation.
4.3 Secondary Processes: Aerobic and Anaerobic Processes: Fixed Film or Attached Growth Systems: Trickling Filters, Bio Towers, Rotating Biological Chambers. Suspended Growth System: activated sludge process, Aerated Lagoon, Constructed Wetlands.
4.4 Other treatment options: septic tank, Imhoff tank, ecoline™.
4.5 Nutrient Removal.
4.6 Digestion and disposal of primary and secondary sludge.

Unit V: Wastewater Disposal and Reuse

5.1 Disposal of sewage by dilution, standards of dilution for discharge of waste water into rivers, self-purification of streams.
5.2 Disposal on land – irrigation, quality standards for waste water effluents to be discharges on land.
5.3 Recycling and Reuse of Waste water.

Unit VI: Plumbing and House drainage

6.1 General principles.
6.2 Systems of plumbing.
6.3 Sanitary fittings.
6.4 Functions and types of traps.
6.5 Testing of house sewers.
6.6 Special plumbing requirements for hospitals; theatres, hotels, industries.

Unit VII: Industrial Waste Treatment

7.1 Introduction, significance, and case studies.

Unit VIII: Solid Waste Management
8.1 Generation and Characteristics of solid wastes.

8.2 Management of Waste at Source: Segregation and transformation of waste at source, Reuse, Storage.
8.3 Methods of Collection.
8.4 Transfer and Transport.
8.5 Treatment and transformation of Waste. Recovery, Reuse and Recycle.
8.6 Methods of Disposal.

List of Practicals:

1. Physical Parameters: pH, Color, turbidity, conductivity, Solids.
2. Chemical Characteristics: Acidity, Alkalinity, Hardness, DO, BOD, COD, Chlorides, Chlorine demand, Optimum alum dose (coagulant), Sulphate, Nitrate, Phosphate.
3. Bacteriological Parameters: MPN, Total Count.

Reading Lists:

Essential Reading

1. Garg, S. K. (2005). Environmental Engineering Volume-II (4 ed.). New Delhi: Khanna Publisher.
2. Metcalf & Eddy Inc. (2005). Wastewater Engineering: Treatment and Reuse. (4 ed.). New Delhi: Tata McGraw Hill.
3. World Health Organisation. (2006). Guidelines for the safe use of wastewater, excreta and greywater - Volume 1Policy and regulatory aspects.United Nations Environment Programme.
4. World Health Organisation. (2006). Guidelines for the safe use of wastewater, excreta and greywater - Volume 2 Wastewater use in agriculture.United Nations Environment Programme.
5. World Health Organisation. (2006). Guidelines for the safe use of wastewater, excreta and greywater - Volume 3 Wastewater and excreta use in aquaculture.United Nations Environment Programme.

Additional Reading

1. Hammer, M.J. (2006).Water and Wastewater Technology (4 ed.). New Delhi: Prentice Hall.
2. Peavy, H.S., Rowe, D.R., & Tchobanoglous, G. (1985). Environmental Engineering. New Delhi: Tata McGraw Hill.
3. Viessman, W. and Hammer, M. J. (2005). Water Supply and Pollution Control. New Delhi: Pearson Education.
4. Sawyer, C.N., McCarty, P.L. & Parkin, G.F. (1994). Chemistry for Environmental Engineering (4 ed.). New York: McGraw Hill.
5. Reynolds, T.D. & Richards, P.A. (1996). Unit Operation and Processes in Environmental Engineering (2 ed.). Boston: PWS Publishing Company.
6. Nathanson, J.A. (2006). Basic Environmental Technology/WaterSupply, Waste Management, and PollutionControl. New Delhi: Prentice-Hall.
7. Hosetti, B.B. (2006). Prospects and Prospective of Solid Waste Management. New Delhi: New Age International.
8. Tchobanoglous, G., Theisen, H. & Vigil, S. (1993). Integrated Solid Waste Management: Engineering Principles and Management Issues. San Francisco: McGraw-Hill.

Date: Janaury 31, 2017

Module Code & Title : **BPD403 Estimating, Costing and Tendering**
Programme : **BE in Civil Engineering**
Credit :**12**
Module Tutor : **Mr. Tshering Tobgyel and Mr. Ugyen Dorji**
Module Coordinator :**Mr. Tshering Tobgyel**

General Objective:

The aim of this module is to provide principles and concepts of estimating, costing (labour and material), tendering and analyse the rate. It will also provide the concept of keeping books of account for civil engineering construction works conforming to specifications and drawings.

Learning Outcomes:

On completion of the module, students will be able to:
1. Carry out the cost estimate of various civil engineering infrastructures using different methods.
2. Estimate the quantities of various materials required for the civil engineering structures.
3. Analyse the rates of the material and manpower as per standard civil engineering practices. .
4. Select the specifications of the construction materials and works.
5. Evaluate the value of the existing structures.
6. Prepare the standard tender documents for construction works.
7. Maintain the various books of accounts.
8. Apply the departmental and contract works related to constructions.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	2	30
Independent study	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VI	2	20	50
1.2	Project Work: Real life estimating and costing through drafting and detailing of construction works with contract documentations. Assessment Criteria (Report): • Architectural detailing. • Structural detailing.	1	30 5 5	

	• Detail estimation. • Abstract cost estimation. • Contract documentation. • Presentation.		10 2.5 5 2.5	
2	Semester End Examination: 3 hours, close book.	1	50	50

Pre-requisites:BPD101Building Materials and Construction, BPD201Building Drawing.

Subject Matter:

Unit I: Quantity Estimation

1.1 Principles of estimation. Simple measurement. Detailed estimate. Deduction and additions. Reducing calculations. Degree of accuracy in estimations. Traditional bricks. Standard modular bricks, Standard sizes of doors, windows and ventilators. Method for finding out dimensions. Out-to-out and in-to-in method. Centre line method. Crossing method. Method of estimation

1.2 Specification of works (BSR) MoWHS specifications. Aims of specifications. Types of specifications. Method of preparations of specifications. General specifications. Detailed specifications. Methods and units. Rule for rounding off number. Successive rounding. Number of figures to be retained.

1.3 General rules for measurement of works. Earthwork. Concrete work. Brick work. Stone masonry. Formwork. Steel work and iron work. Roof covering. Ceiling and lining. Paving, floor finishes, dado skirting. Plastering and pointing. White washing colour washing, distempering and other finishes. Painting, polishing, varnishing etc. Roadwork. Demolition and dismantling. Water supplying, plumbing, drains and sanitary fittings. Woodwork and joinery.

1.4 Estimation of materials in building, arches, R.C.C, Steel Works, culverts, bridges, Earthwork and road works with other civil engineering structures.

Unit II: Rate Analysis

2.1 General. Purpose of rate analysis. Importance of rate analysis. Requirement of rate analysis. Factor affecting rate analysis. Procedures of rate analysis. Table. Requirement of labour for different works.

2.2 Estimated quantity of material required per cum compacted concrete. Quantities required of materials required per sqm for various thickness of plaster. Voids in river sand and stone aggregate. Quantities of materials per sqm for various thickness of concrete screed. Quantities of materials required for cement concrete of different proportions. Quantities of materials required for brickwork, random rubble stone masonry, ashlar, pointing in different proportions of mortar. Requirement of materials for various items of works.

2.3 Material rates. Labor rates. Analysis of rates for building, roads, and other structures as per current practice of Bhutan Schedule of Rates.

Unit III: Principles of Specification

3.1 Principle of general specifications of buildings and other prominent structures.

3.2 Detailed specification of various building works, maintenance works and other prominent structures included in unit II sec 1.2 above corresponding with Bhutan Specification shall be discussed.

Unit IV: Tendering and Documentation

4.1. General. Requirement of contract. Contracts and type of contracts. Lump sum Contract, Item rate contract. Percentage contract. Contract Documents. Security for performance of contracts, Conditions of contract. Termination of contract. Labor contracts. Negotiated contracts. Earnest money. Security deposit.
4.2. Types of tender. Security of tenders. Acceptance of tenders. Power of accepting tender. Tender Notice. Award of contract. Legal problems in contract. Arbitrator and role of arbitrator in civil related works. Enforcement of contract terms and conditions.

Unit V: Valuation

5.1 General. Objects of valuation. Free-hold property. Lease-hold property. Property income. Obsolescence. Market value. Book value. Distress Value. Monopoly value. Salvage value. Sentimental value. Speculative value. Municipal taxes. Present value of an Annuity. Mortgage. Essential rights. Capital cost. Capitalized Value.
5.2 Depreciation. Year's purchase. Methods of determining depreciations. Valuation of real properties (buildings etc.).Cost of land. Valuation tables. Typical valuation reports.
5.3 Types of rents. Rules of capital cost fixation of Bhutan buildings. Rules for calculation of standard rents. Rent Statements. Solve examples. Rent fixation of buildings.

Unit VI: Accounting and Financial Administration:

6.1. General. Function of treasury. Withdrawal of money from the government account. System of Accounts. Divisional accounts.
6.2. General principles of accounts, Cash charges. Payment to laborers. Payment to contractors and suppliers. Standard measurement books. Review of measurements. First and final bills. Running account bills. Advance payments.
6.3. General instructions for preparations of bills. Preparation, examination and payment of bills. Payment to worked charged establishment. Imprest account. Permanent advance. Cheques. Receipt of money. Treasury Challan. Treasury remittance book. Contractor's ledger. Payments of works executed on lump sum contract. Cashbook. Travelling allowance. Permanent travelling allowance. Daily allowance. Rates of daily allowance. Introduction to Financial Manual of Bhutan. Construction Ethics of CDB, Bhutan.

Reading Lists:

Essential Reading

1. Dutta, B.N. (2004). Estimating and Costing in Civil Engineering – Theory and Practice Including Specifications and Valuation. New Delhi: UBS Publishers.
2. Birdie G.S. (1988). Text Book of Estimating and Costing (Civil Engineering). New Delhi: Dhanpat Rai & Sons.
3. Rangwala, S.C. (2001). Estimating, Costing and Tendering [Professional Practice]. New Delhi: Charotar Publishing House.
4. Patil, B.S. (2006). Civil Engineering Contracts and Estimates (3 ed.). Universities Press.
5. Goyal, S.C. and Jain, O.P. (2001). Manual Estimating. Roorkee: Nem Chand & Bros.

Additional Reading

1. Arya, A.S. (2000). Masonry and Timber Structures including Earthquake Resistant Design. Roorkee: Nem Chand & Bros.
2. Bellis, H.F. and Schmidt, W.A.(2001). Architectural Drafting. London: McGraw-Hill.
3. Khanna, P.N. (2001). Indian Practical Civil Engineers' Handbook – the standard ever-day reference book for all engineers & architects. New Delhi: Engineers Publishers.
4. Hoelscher, R.P. and Springer, C.H. (2002). Engineering Drawing & Geometry. London: John Wiley & Sons Inc.
5. Construction Ethic (2015).CDB. MoWHS. Thimphu: Bhutan.
6. BSB. (2013). Specifications for Building & Road Works, Bhutan Schedule of Rates, Labor & Material Coefficient (Civil).
7. Ministry of Finance. (2009). Procurement Manual. Thimphu: Bhutan.
8. Ministry of Finance. (2001). Financial Manual. Thimphu: Bhutan.

Date: Janaury 31, 2017

Module Code & Title : **HWE401 Highway Engineering**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Sangey Pasang, Mr. Leki Dorji and Mrs. Tshering Cheki**
Module Coordinator : **Mr. Sangey Pasang**

General Objective:

The module aims to provide the fundamental principles of design, planning, construction, selection of appropriate materials, conduct experiments, formulate traffic flow, traffic characteristic measurements and their interpretation for infrastructure development.

Learning Outcomes:

On completion of the module, students will be able to:
1. Design the geometric alignment of a highway.
2. Evaluate a suitable pavement of a highway for a given condition.
3. Select the appropriate materials for use in different road layers.
4. Appraise the quality and performance of unbound and bound road materials.
5. Interpret geometric design fundamentals, in relation to safety and driver comfort, focusing on horizontal and vertical alignment.
6. Design the geometric curves of a road pavement.
7. Forecast future traffic flows along highway links.
8. Analyze the need for maintenance work to it at some future point in its useful life.
9. Perform the traffic studies necessary before making changes to or designing new road infrastructure.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Practical	2	30

Independent study/self-directed learning	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VIII	2	20	25
1.3	Assignment I: in 5th week, Unit I-III (Evaluate a suitable pavement of a highway for a given condition) - The principles of evaluation - Knowledge of Road /Pavement conditions of Bhutan - Material used Assignment II: in 10th week Unit IV-VII (Interpret geometric design fundamentals, in relation to safety and driver comfort, focusing on horizontal and vertical alignment). - Data interpreted - Assumptions made (if required) - Steps considered for design	1	5	
2	Continuous Assessment (Practical)			
2.1	Regular assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).	1	15 1.5 4.5 3 3 3	25
2.2	Practical examination/Viva-voce/Quiz:	1	10	
3	Semester End Examination: 3 hours, closed book.	1	50	50

Pre-requisites: None

Subject Matter:

Unit I: Introduction

1.1 History of roads in Bhutan.
1.2 Road Development policies of Bhutan.
1.3 Types of roads.
1.4 Construction approaches (Traditional road construction, EFRC, Equipment based and labour based).
1.5 Government policies and acts relating to road construction.

Unit II: Highway Network Planning

2.1 Role of Highway transportation.
2.2 Special Characteristics.
2.3 Network Patterns.
2.4 Planning Surveys.
2.5 Highway Traffic forecasting.
2.6 Time series Models.
2.7 Prediction of Inter regional Traffic through average growth factor method.
2.8 Elasticity method.
2.9 Master plan preparation.
2.10 Evaluation by Saturation method.

Unit III: Highway Alignment and Geometric Design

3.1 Principles of highway alignment.
3.2 Feasibility Studies: Reconnaissance survey, Desktop study of the alignment, Google maps, topo-maps, aerial photo interpretation, Satellite imagery.
3.3 Route corridor Options and Selection factors to be considered.
3.4 Geotechnical study.
3.5 Environmental assessment and social assessment.
3.6 Ghat tracing.
3.7 Detailed survey of the alignment.
3.8 Generation of contour maps.
3.9 Types of retaining and CD structures.
3.10 Cross section elements: Lanes, camber, shoulders, medians, road margins, right of way, cross fall, hillside slopes, embankments, balance cut and fill.
3.11 Horizontal elements: sight distance, super elevation, transition curves.
3.12 Vertical alignment: gradients vertical curves.
3.13 Design of intersections.
3.14 At grade intersections-Rotary Intersections.

Unit IV: Highway Materials and Design

4.1 Types of highway materials.
4.2 Properties and testing of aggregate and bitumen
4.3 Design of bituminous mixes by marshal stability method.
4.4 Types of pavements.
4.5 Factors affecting pavement.
4.6 Design: CBR method, Westergard's analysis, IRC method of Flexible and Rigid pavement Design

Unit V: Highway Construction and Maintenance

5.1 Types of highway construction.
5.2 Methods, choice, general principles, IRC & DOR specifications for the construction of Earth, WBM, Bituminous and cement concrete roads.
5.3 Formation cutting: Use of appropriate equipments, Phased cutting, earthwork management, bench cutting, maintaining proper slopes & gradients, temporary drains, stacking of useful materials, top soil collection & reapplication, half/quarter/full tunneling.
5.4 Rock excavation: Controlled blasting: Design, drilling/loading/charging patterns, blasting materials; silent blasting, feather-wedges etc.
5.5 Maintenance of roads: Types of maintenance: routine, periodic & emergency maintenance, Maintenance system: including community based maintenance; Performance based routine maintenance, combined approaches.

Unit VI: Slope Stabilization Works

6.1 Terrain evaluation and slope dynamics: forms and processes of slope instability.
6.2 Mapping of landslides and potentially unstable slope conditions.
6.3 Landslide risk assessment and work prioritization.
6.4 Design of slope stabilization and protection systems: Log/boulders/trench barriers, Gabion Bolsters, Anchor walls, Rock bolting, Shotcreting, Reinforced earth wall.
6.5 Retaining structure: (gabion walls, crib wall, drum wall, boulder walls etc), Geotextile treatment, Crash barriers, proper signage's, Noise barriers.

Unit VII: Bioengineering

7.1. Site assessment and survey.
7.2. Selection of plants and grass species.
7.3. Bioengineering tools and structures.

Unit VIII: Traffic Engineering Principles

8.1 Components of Traffic Stream: Volume, speed and density, measurement andanalysis, their relationships.
8.2 Design Hourly volume, concept of EPCU, service volume.
8.3 Level of service concept and application to highway design.

Unit IX: Traffic Management and Control

9.1. Traffic Control device, description of signs, markings and signals.
9.2. Management principles: One-Way streets, parking management principles: One-Way streets, Parking management.
9.3. Accidents: Recording and Analysis using IRC forms, Speed breakers, M.V Act. Traffic signals.

List of Practical:

1. Test on Aggregate: Aggregate suitability evaluation through the following tests – abrasion, impact, crushing, Specific gravity, Water absorption & shape tests, Impact value test, Soundness test.

2. Tests on Bitumen and tar: Penetration, Ductility, Softening point, Viscosity, Stripping, Flash and fire point, Bitumen extraction
3. Test on soil: CBR test at OMC. Soaked CBR, Field CBR through Klegg's impact test, DCP-CBR.
4. AC Mix Design: Mix design, Marshall Stability method.
5. Exercises on Traffic Engineering: Traffic volume and speed studies including data analysis parking usage surveys.
6. Pavement condition studies: Visual Methods and pavement evaluation using Benkleman Beam method.

Reading Lists:

Essential Reading

1. Khanna, S.K. and Justo, C.E.G. (1998). Highway Engineering. Roorkee: Nem Chand Bros.
2. Khanna S.K and Justo, C.E.G. (1998). Highway Material Testing. New Delhi: Nem Chand Publications.
3. Kadiyali, L.R. (2008). Traffic Engineering and Transportation Planning. New Delhi: Khanna Publishers.
4. Papacostas, C.S. (2002). Fundamentals of Transportation Engineering. New Delhi: Prentice Hall of India Private Limited.
5. Nicholas J Garber, Lester A Hoel and Raju Sarkar, "Traffic and Highway Engineering"

Additional Reading

1. John Khisty, C. (2011). Transportation Engineering - An Introduction. New Jersey: Prentice Hall, EngiewoodClitts.
2. IRC Code of Practice (2014).
3. Asphalt Institute of America Manuals (2001).
4. Code of Practice of BIS (2008).

Date: Janaury 31, 2017

BE (Fourth Year) – Eighth Semester

Semester VIII				Contact Hours			Marks		
							Theory		Pract
#	Code	Module	Credit	L	T	P	CA	EX	CA
1	MGT401	Project Management	12	3	1	0	50	50	0
2	******	Elective -I	12	*	*	*	*	*	*
3	PRW402	On-the-Job-Training (OJT)	12	0	0	0	100	0	0
4	PRW403	Project Work	24	0	0	2	80	20	0
		Total	**60**						

Note : * Refer to Elective Module Descriptor

Module Code & Title :MGT402 Project Management
Programme :BE (Civil Engineering)

Credit : **12**
Module Tutor :**Mr. Nima Drukpa & Mrs. Tshewang Dema**
Module Coordinator :**Mrs. Tshewang Dema**

General Objectives:

This module aims to introduce students to the essential concepts of project management that are required for engineering students. The module is designed to develop understanding of a project, general management functions, and techniques of project management. Further, the module will enable students to handle projects for various public and private sector organizations.

Learning Outcomes:

On completion of the module, students will be able to:

1. Define the project management principles
2. Adopt personnel management skills
3. Explain the project life cycle and its relation to project management knowledge areas.
4. Develop/Create Work Breakdown Structure for projects
5. Estimate project time and cost.
6. Schedule project activities/ Carry out project scheduling
7. Appraise the significance of procurement plan and human resource management for successful project completion.
8. Evaluate project risks and develop risk response plan.
9. Evaluate project progress & quality
10. Determine how to phase out project and analyse lessons learnt
11. Develop the ability to function as a project manager.
12. Acquaint/Acquire the skills to communicate effectively on a project team.

Learning and teaching approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Self-directed learning	4	60
Total		120

Assessment Approach:

Sl. No.	***Mode of Assessment***	***Nos.***	***Marks Allocated***	***Marks (%)***
1	**Continuous Assessment (Theory)**			
1.1	2 Assignment/Case Study duration in 6th and 11th week (Case study on Real life project -20 marks and Presentation in groups-10 marks) Assessment Criteria(Case Study) : • Introduction(2) • Format and organization of information(2)	2	30	**50**

	• Content depth and accuracy (5) • Relevancy of information (5) • Conclusion(2) • References(2) • Time(2) Assessment Criteria (Presentation): • Organisation of slides(2) • Style (2) • Audibility (1) • Use of visual aids (2) • Responsiveness to audience (2) • Time (1)			
1.2	Term Tests: Closed book, One Hour duration in 5th and 10th week (Term Test 1- Unit I- II and Term Test II- Unit III-VII)	2	20	
2	**Semester End Examination:** 3 hrs duration, closed book in 16th week	1	**50**	**50**

Students must obtain 40% each in the Continuous assessment of theory and the semester end examination. The overall pass mark for the module is 50%.

Pre-requisites: None

Unit I: Introduction to Project

1.1 Define Project & Project Management
1.2 Define key terms: Operation, Program & Portfolio
1.3 Project Life Cycle
1.4 Project Stakeholders
1.5 Organizational Structure
1.6 General Managerial Functions: Planning, Organizing, Leading & Controlling
1.7 Project manager's Roles and responsibilities
1.8 Project constraints

Unit II: Project Scope Management

2.1 Define statement/scope of work
2.2 Work Breakdown Structure
2.3 Scope Verification and Control

Unit III: Project Time and Cost Management

3.1 Define project tasks/activities
3.2 Activity sequencing (Identify and document interactivity dependencies)
3.3 Estimate activity time, cost and budget.
3.4 Schedule Development (Create Gantt Chart and Network Diagrams: CPM, PERT, PDM)
3.5 Perform Earned Value Analysis.

Unit IV: Project Human Resource Management

4.1 Organizational Planning
4.2 Staff Acquisition
4.3 Team Development

Unit V: Project Procurement Management

5.1 Procurement Planning
5.2 Documenting product requirements and identifying potential sources
5.3 Obtaining quotations and selection from potential sellers
5.4 Completion and settlement of the contract with the seller.

Unit VI: Stakeholder and Communication Management

1.10 Stakeholder Analysis
1.11 Communication Plan
1.12 Information Distribution
1.13 Performance Reporting
1.14 Administrative Closure

Unit VII: Managing Project Risk

7.1 Risk identification (Quantitative & Qualitative)
7.2 Risk response plan
7.3 Risk monitoring and control.

Unit VII: Managing and Monitoring the Project Schedule

8.1 Update Project Plan and Schedules; Status meetings and reports; Dealing with issues; Manage Project Team.

Unit IX: Project Quality Management

9.1 Define quality; Quality Management Process (TQM); Resolving quality issues; Quality assurance and control.

Unit X: Managing Project Completion

4.4 Phasing out task/activities, Close the project; Lessons learnt.

Reading Lists:

Essential Reading

1. Kerzner H. (2009) *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (10th Edition.). New Delhi- Wiley India Pvt. Ltd.
2. Punmia B C & Khandelwal K K. (2002) *Project Planning and Control with PERT and CPM.* New Delhi- Laxmi Publications Pvt. Ltd.
3. CADD Centre (2001). *Project Planning & Management –Reference Guide*. CADD Centre Training Services private Ltd.
4. American National Standard; *A Guide to Project Management Body of Knowledge* (Fifth Edition). Project Management Institute, Inc. USA.

Additional Reading

1. Koontz H & Weihrich H (2009); *Essentials of Management* (5th Edition). Tata McGraw Hill.

2. Meredith J R & Mantel S J (2012); *Project Management- A Managerial Approach* (Eight Edition). New Delhi- Wiley India Pvt. Ltd.
3. Joseph H (2011); *Fundamentals of project management* (4th Edition). American Management Association, New York.
4. Clements, J.P.(2009*). Effective project management.* New Delhi: Cengage Learning.
5. Gray, Clifford. (2006). Project Management (3rd Edition). New Delhi: Tata McGraw-Hill.
6. Raina V K (2009); *Construction and Contract Management Practices- The inside story* (2nd Edition). Shroff Publishers and Distributors Pvt. Ltd, India.

Date: Janaury 31, 2017

Module Code and Title	**:**	PRW402 On–The-Job-Training
Programme	**:**	BE in Civil Engineering
Credit	**:**	12
Module Tutor	**:**	All tutors
Module Coordinator	**:**	Mr Tsheten Dorji

General objectives:

The purpose of the attachment program is to gain practical experience from a real industrial environment and instill in the students the right kind of work attitude and work professionalism, so that they can become effective and productive to their respective organizations much sooner than is usual for fresh graduates.

Learning Outcomes:

On completion of the module, students will be able to:

1. Strengthen work values through an improved understanding of themselves and the work environment
2. Gain interpersonal skills that promote personal growth and development.
3. Apply own skills and knowledge learned in the institute
4. Acquire skills needed to become practice-oriented engineers
5. Nurture the spirit of professionalism and develop professional ethics for students in a real life environment.
6. Familiarize with the operation of a company or industry or a manufacturing plant, including its organization structure, management style, sources of raw materials, inventory control, marketing channels, and other logistic supports.
7. Prepare a written report and present to a professional audience.

Learning and teaching approach:

All students need to undergo OJT in relevant organizations as part of their degree programme. The period of attachment is 45 days including weekends. The students will be sent on OJT at the end of 7th Semester. Students are expected to identify and request organizations for OJT placement by themselves. The OJT placement need to

be related to the field of study. Incase if the students are not able to find OJT placement, then the College through Dean of Research and Industrial Linkages will facilitate placement of students in relevant organization.

Assessment approach:

The student's performance during OJT will be assessed as detailed below.

- Field evaluation : 20%
- Written report : 40%
- Oral presentation : 25%
- Log book : 15%

Each student will be assessed individually.

Areas to be evaluated			Marks
1	**Field Evaluation (by Supervisor)**		**20**
	1.1	Attendance and punctuality	2
	1.2	Work Attitude and Ethics	3
	1.3	Problem Solving capability	3
	1.4	Taking initiatives and working within their calibre	3
	1.5	Ability to adapt to work environment	3
	1.6	Rapport with work colleagues	3
	1.7	Contribution to the organization	3
2	**Report evaluation**		**40**
	2.1	Cover page design and presentation	1
	2.2	Abstract	3
	2.3	Acknowledgement	1
	2.4	Correct implementation of Format , language and style	8
	2.5	Introduction to the organization	3
	2.6	Technical and field work details	15
	2.7	Observations and discussions	7
	2.8	Recommendations	2
3	**Presentation**		**25**

	3.1	Presentation Techniques	3
	3.2	Content (Technical + Field work carried out)	7
	3.3	Response to the Questions	10
	3.4	Language (Verbal clarity) and confidence	5
4	**Log Book**		**15**
	4.1	Presentation of log book	2
	4.2	Appropriate reporting of daily activities	8
	4.3	Clarity (legibility, completeness, sequential)	5

Students will submit a printed report no later than 2nd week of 8th semester and presentation will be organised in 3rd week. If a student is placed in the organisation alone, he/she will be asked to present his/her report in 15 minutes and another 15 minutes for question answer session. Incase if the students are placed in an organisation in groups then each student will be allotted 10 minutes for presentation and 10 minutes for question answer session.

Prerequisites: None

Subject Matter (Guideline for OJT):

The general guidelines for the students during the OJT are:

1. During OJT, students will follow the normal office working hours of the organization and maintain log of daily activities. At the end of the OJT period, students have to submit a printed report and also present their report to the committee appointed by the programme leader.
2. On-site monitoring may be conducted by tutors at least once during the course of the OJT after 3rd week of job placement to ensure student's progress. During the field visit, students will be asked to present about the activities that they are carrying out at the sites. Visits will be planned to coincide with the student's work schedule and at a time students' supervisor is available for meeting.
3. Students will maintain log of daily activities which must be signed by the supervisor or employer. The visiting tutor will review each student's log book to ensure that the required information is filled appropriately and they are gainfully used.
4. The visiting tutor will also discuss with the students' supervisor(s) about the strengths and weaknesses, and obtain feedback on performance of the students.
5. At the end of the OJT, students must request a letter from the supervisor/employer commenting on the engagement of the student during the OJT and highlighting any particular achievements.
6. Students must complete a final report conforming to the report marking schemes

Reading List: None

Date: 4th February 2017

Module Code and Title	: PRW403 Project Work
Programme	: BE in Civil Engineering
Credit	: 24
Module Tutor	: All Tutors
Module Coordinator	: As appointed by Programme Leader

General Objective:
The objective of this module is to enable students to apply theoretical knowledge to an engineering problem and improve their analytical skills in engineering. It will also enable students to test general engineering ability.

Learning Outcomes:
On completion of the module, students will be able to:
1. Explore literature and reference sites for research and project work
2. Formulate the problem for the specific project of his/her interest.
3. Analyse the technical and economic implications of the proposed project.
4. Appraise themselves with the processes involved in project execution.
5. Interpret the problem areas and contingencies.
6. Formulate the outcomes of project work
7. Infer technical reasons for the project outcome.
8. Prepare a written report and present to a professional audience.

Learning and Teaching Approach:
Directed reading and assigned problems develop inquisitiveness for bridging the current research loopholes and assist in research problem formulation. Application oriented projects require knowledge of various industrial standards and utility aspects, which can be gathered through directed studies.
Students will be divided into groups comprising of 3-6 members. Each group will be guided by a tutor with minimum of Masters Qualification. Tutors who do not have experience in project supervision or without Master's degree may be appointed as co-guide. A tutor may guide more than one group. The choice of guide(s) will be based on the interest of the students and they will be required to choose their guide(s) from the pool of tutors available within the department or from other department with the consent of the programme leader. Students will be divided into groups based on the merit ranking till 5^{th} semester. The programme leader in consultation with the tutors will ensure that not all the top ranking students are in one group. Group formation and selection of guide(s) shall be done before the end of the 6^{th} semester.

Project work will begin in the 7^{th} semester and complete in 8^{th} semester. The students are expected to decide their project topics by 4^{th} week of the 7^{th} semester and present their proposal to the committee in the 6^{th}week. If the topics are not within the standard expected at undergraduate level or the committee feels that students will not be able to complete within the given time frame, they may be asked to resubmit within next two weeks. At the end of the 12^{th} week, there will be 1^{st} review of

the project during which students are expected to present their work progress after the proposal presentation.

In the 4th week of the 8th semester, there will be second review of the project during which students are expected to present their project progress after the 1st review. Final or the third review will be conducted in the 10th week. During the review, students will present progress of their work after the last review only.

Approach	**Hours per Week**	**Total Credit Hours**
Interaction with supervisor to discuss project progress	1 each for 2 Sems	30
Independent study/self-directed learning	7 each for 2 Sems	210
Total		240

In order to encourage publication of project works, the College will facilitate and organise annual students' research meet on the last Saturday of April.

Assessment Approach:
The project work evaluation is in four parts as shown below. Out of a total of 100 marks, 60 marks are allocated for internal continuous assessment, 20 marks for project report evaluation, 15 marks for final project presentation and 5 marks for submitting scientific paper for *ZORIG MELONG*, technical journal published annually by the college. The detail marking scheme is shown below.

Sl No	**Activities**	**Due date (week)**
1	Grouping of students	12th week of 6th Semester
2	Finalization of topic	4th week of 7th Semester
3	Proposal presentation	6th week of 7th Semester
4	1st review	12th week of 7th Semester
5	2nd review	4th week of 8th Semester
6	3rd review	10th week of 8th Semester
7	Final presentation	14th week or after the 8th Semester end examination

The detail marking scheme is shown below.

Areas to be evaluated			**Marks**
1	**Continuous Assessment**		**60**
	1.1	Proposal presentation	10
	1.2	1st review	10
	1.3	2nd review	10
	1.4	3rd review	10
	1.5	Regular work (by supervisor)	20
2	**Report Evaluation (External)**		**20**

	2.1	Abstract	1
	2.2	Introduction	1
	2.3	Literature review	3
	2.4	Technical content	5
	2.5	Results	5
	2.6	Originality	2
	2.7	Practicality	2
	2.8	Conclusion	1
3	**Project Presentation**		**15**
	3.1	Presentation Techniques	2
	3.2	Content	4
	3.3	Response to the Questions	7
	3.4	Language (verbal clarity) and confidence	2
4	**Writing scientific paper**		**5**
	Total Marks		**100**

Project proposal presentation will consist of 15 minutes oral presentation by one of the group members and 15 minutes question and answer session. The committee may ask any one member to present.

Proposal Presentation	**10**
Aim and objectives	2
Methodology	4
Expected outcome	1
Feasibility	1
Originality and practicality	1
Work plan	1

During the project review, one of the members will be asked to present for 15 minutes followed by 15 minutes question answer session.

Project Review Presentation	**10**
Work progress	6
Response to questions	3
Future work	1

Regular Work (Continuous Assessment by Project Guide)	**20**
Actual work involvement	2
Team sprit & work culture	2
Conceptual understanding	2
Punctuality	2
Planning & execution/ compliance in carrying out guides	2

instruction	
Technical background materials collection	2
Analysis & interpretation capability	2
Time Management	2
Technical writing skills	2
Computational/logical ability	2

Prerequisites: PWR301 Introduction to Research
Subject Matter:
This will depend on student's interest and guide's expertise. The final report must be as per the format set by the College.
Reading List: Conference paper, journal articles and other books that are relevant to the chosen title.

Date: March 26, 2016

6 DEPARTMENTAL ELECTIVES

Elective I			Contact Hours			Credit	Marks		
							Theory		Pract
#	Code	Module	L	T	P		CA	EX	CA
1	EQE401	Earthquake Resistant Design of Structures	3	1	0	12	30	70	0
2	GIS401	Geographic Information System and Applications	3	1	2	12	25	50	25
3	DOS 405	Bridge Engineering and Design	3	1	0	12	30	70	0
4	DOS406	Prestressed Concrete Structures	3	1	0	12	30	70	0
5	EVE404	Water Resources Planning and Management	3	1	0	12	30	70	0
6	EVE405	Environmental Geo-technology	3	0	0	12	30	70	0
7	HWE402	Traffic Engineering	3	0	0	12	30	70	0
8	BPD404	Sustainable Building Planning and Design	3	0	0	12	30	70	0
9	HWE403	Slope Stability on Mountain Roads	3	1	0	12	30	70	0

Note : * Refer to module matrix of VIII semester

Module Code & Title : EQE401 Earthquake Resistant Design of Structures
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mr.Tshewang Nidup

General Objective:

This module introduces the basics engineering seismology and fundamental concepts and practice of earthquake resistant design of buildings. This module builds knowledge of Risk Analysis, Dynamics, and Structural Theory and Design to allow students to be familiar in this specialized area. Codal provisions for earthquake resistant design as per relevant international standards are explained.

Learning Outcomes:

On completion of the module, students will be able to:

1. Describe seismicity of the world and explain where, how and why earthquakes occur.
2. Accurately interpret strong ground motions through response spectra presented in the different formats including the Acceleration-Displacement Response Spectrum (ADRS).
3. Accurately interpret performance limit states.
4. Solve equations of motion of vibrating structures,
5. Explain how damping affect structure response to vibration and find damping ratio of vibrating structures
6. Describe how buildings respond to earthquakes and the effect of site condition and building's dynamic properties on the overall response.
7. Calculate the design seismic forces on buildings based on Equivalent lateral static forced Method and modal analysis method.
8. Undertake seismic design and assessment of building structures.
9. Employ capacity design principles and the concept of strength hierarchies to ensure that the structure responds to an earthquake in the desirable way.
10. Explain the importance of ductility in Earthquake resistant design of Buildings
11. Assess existing building structures and provide plans for their effective retrofitting techniques, device
12. Exhibit clear understanding on the short comings of current design assumptions and explain recent developments in earthquake design philosophies.

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Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Written assignment	1	15
Independent study	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week Unit IV-VI	2	20	30
1.3	Assignment I: in 4th week, Unit I-II (Explain the theory of seismology and vibration and define its elements). - Conceptual Understanding : 2 - Application of Concept : 2 - Accuracy and Correctness :1 Assignment II: in 8th week, Unit III-IV	2	10	

	(Conduct seismic analysis and design using IS: codes manually and with Software). - Conceptual Understanding : 2 - Application of Concept : 2 - Accuracy and Correctness :1			
2	Semester End Examination: 3 hours, closed book	1	70	70

Pre-requisites: DOS302 & DOS404 Design of Reinforced Concrete Structures-I & II, DOS301 & DOS303 Design of Steel Structures-I& I

Subject Matter:

Unit I: Fundamentals of Engineering Seismology

1.1. Continental drift theory, Plates Tectonics, Elastic Rebound Theory,
1.2. Seismic Waves,
1.3. Types of Earthquakes,
1.4. Earthquake Size : Magnitude and Intensity,
1.5. Local Size Effects,
1.6. World Seismicity and Seismicity of South East Asia, Seismic Zoning Map.

Unit II: Ground Motion Studies and Estimation of Seismic Hazards

2.1 Nature of Ground Motion,
2.2 Strong Motion Characteristics,
2.3 Peak Ground Acceleration, Peak Ground Velocity, Peak Ground Displacement, Duration of shaking.
2.4 Response Spectra and Design Spectrum – Corner Periods

Unit III: Introduction to Structural Dynamics

3.1 Introduction to dynamics – D'alemberts principles
3.2 Free undamped and damped vibration
3.3 Effects of Damping – overdamped, underdamped and critically damped structures
3.4 Forced Vibration of Single Degree of freedom Systems,
3.5 Multi degree freedom Systems - Fundamental Frequency and Mode shapes

Unit IV: Concept of Earthquake Resistant Design

4.1 From earthquake Acceleration to Seismic Response(Equal Acceleration, Equal Energy, and Equal displacement concepts)
4.2 Seismic Damages from past earthquakes,
4.3 Effects of Structural Irregularities,
4.4 Seismo-resistant Building Architecture.
4.5 Earthquake Resistant Design Philosophy (Performance Based Design)
4.6 Response Reduction factor – Concept of ductility

Unit V: Seismic Analysis and Modeling

5.1 Earthquake Design Base shear
5.2 Bases shear based on Equivalent Lateral static Loading
5.3 Lateral Load distribution
5.4 Base shear based on modal analysis (dynamic analysis)

5.5 Response Spectrum Method

Unit VI: Earthquake Resistant Design

6.1 Ductility Consideration,
6.2 Member Designs - Flexural and Compression,
6.3 Capacity Based Design principle - Soft Story Issues, Strong Column - Weak Beam Mechanism, Moment Magnification factor for Columns
6.4 Design of Shear Wall,
6.5 Effect of infill panels

Unit VII: Seismic Evaluation and Protection Techniques

7.1 Seismic capacity evaluation,
7.2 Strategies and techniques for retrofitting
7.3 Conventional protection techniques
7.4 Base Isolation and Energy Dissipation Techniques,
7.5 Protection of Non- Structural Components.

Unit VIII: New Development in Earthquake Engineering.

8.1 Myths and Fallacies of Earthquake Engineering,
8.2 Problems with conventional Forced based Design approach,
8.3 Introduction to Displacement Based Design Principle

Reading list:

Essential Reading

1. Priestley, M.J.N., Calvi, G.M., and Kowalsky, M.J., Displacement-Based Seismic Design of Structures, IUSS Press, 2007
2. Priestley, M.J.N., Calvi, G.M., and Paulay, T., Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons, 1992
3. Agrawal, P., & and Shrikhande, M., Earthquake Resistant Design of Structures (1st edition). New Delhi: Prentice Hall of India Pvt. Ltd, 2010.
4. Applied Technology Council, (1996). Seismic Evaluation and Retrofit of Concrete Buildings Vol 1, California Seismic safety Commission
5. Chopra, A.K. (1995). Dynamics of Structures- Theory and Application to Earthquake Engineering. New Delhi: Prentice Hall, NJ.

Additional Reading

1. Priestley, M.J.N., Calvi, G.M., and Kowalsky, M.J., Displacement-Based Seismic Design of Structures, IUSS Press, 2007
2. Priestley, M.J.N., Calvi, G.M., and Paulay, T., Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons, 1992
3. Agrawal, P., & and Shrikhande, M., Earthquake Resistant Design of Structures (1st edition). New Delhi: Prentice Hall of India Pvt. Ltd, 2010
4. Applied Technology Council, (1996). Seismic Evaluation and Retrofit of Concrete Buildings Vol 1, California Seismic safety Commission
5. Chopra, A.K. (1995). Dynamics of Structures- Theory and Application to Earthquake Engineering. New Delhi: Prentice Hall, NJ.

Date: Janaury 31, 2017

Module Code & Title :**GIS401 Geographic Information System and Applications**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Sangey Pasang, Mr. Leki Dorji and Mr. Kirtan Adhikari**
Module Coordinator : **Mr. Sangey Pasang**

General Objective:

The module aims to introduce the concepts of Geographic Information System (GIS) and its applications to Engineering. Through this module, students will understand the basic principles of GIS, creation of GIS database and develop basic practical skills in using GIS software for data input and processing to obtain desired output in the form of maps. Students will also learn how to use field data, maps, as well as how to interpret aerial and satellite data in GIS software.

Learning Outcomes:

On completion of the module, students will be able to:
1. Explain the importance of GIS in engineering.
2. Create spatial data and its attribute in GIS software
3. Analyse spatial data in GIS software for various projects.
4. Explain different methods of map projections.
5. Produce maps with different scale and projections.
6. Generate Digital Geographic Data.
7. Interpret satellite images and aerial photographs.
8. Integrate the GPS and survey data to GIS data.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Practical	2	30
Independent study/self-directed learning	2	30
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-II Term Test II: in 10th week, Unit III-IV	2	20	25
1.2	Assignment I: in 4th week, Unit I-II (Create spatial data and its attribute in GIS software and analyse spatial data in GIS software for various projects). - Conceptual Understanding : 1	2	5	

	- Application of the Concept : 1 - Accuracy and correctness : 0.5 Assignment II: in 9th week, Unit III-IV (Explain different methods of map projections and generate Digital Geographic Data). - Conceptual Understanding : 1 - Application of the Concept : 1 - Accuracy and correctness : 0.5			
2	Continuous Assessment (Practical)		15	
2.1	Regular assessments: Assessment criteria (Lab Report) • Introduction (theory, principle, significance and expected outcomes). • Materials and methods (materials used to do the practical with proper specification and step by step procedure followed by the student while conducting the experiment. This section should have enough detail so that reader can repeat the experiment). • Precaution (rules need to be followed in order to perform the practical with higher precision). • Results (state outcomes of the experiment but not interpret or draw conclusions about the data). • Conclusion (state what student has learned by doing the experiment).	1	15 1.5 4.5 3 3 3	25
2.2	Practical examination/Viva-voce/Quiz:	1	10	50

Prerequisites: None

Subject Matter:

Unit I: Basic Concept of GIS:

1.1 Introduction - Information Systems, spatial and non-spatial information Geographical concepts and terminology.
1.2 Advantages of GIS, Basic components of GIS.
1.3 Commercially available GIS hardware and software, organisation of data in GIS.

Unit II: GIS Data

2.1. Input data – Field data, Statistical data, Maps, Aerial Photographs, satellite data, points, lines and areas features.
2.2. Vector and Raster data, Advantages and Disadvantages.
2.3. Data entry through keyboard, digitizer and scanners.

2.4. Digital data, processing of data – Rectification and registration, Interpolation techniques.

Unit III: Data Management

3.1 Characteristics of attributes, a GIS links attribute and spatial data(DBMS).
3.2 Various data models, Run – length encoding, Quadtrees.
3.3 Data Analysis – Data layers, analysis of spatial and non- spatial data, Data overlay and modelling.
3.4 Data presentations – Hardcopy devices, softcopy devices.

Unit IV: Applications of GIS

4.1 Applications of GIS in Map Revision.
4.2 Civil Engineering projects.
4.3 Land use, Agriculture, Forestry, Archaeology, Municipal, Geology.
4.4 Water resources, Soil erosion, Land suitability analysis, Change detection.

List of practical:

1. Demonstration and familiarization of GIS software.
2. To study the types of geo referencing of satellite images.
3. To practice different types of digitization of satellite images.
4. To study the different methods of map projections.
5. To create the spatial data and it's attribute in GIS software.
6. To generate digital geographic data from satellite images and topo sheets.
7. To analyse spatial data for various project in GIS software.
8. To produce the maps with different scales and projections.
9. To integrate the GPS and Survey data to GIS software.

Reading Lists:

Essential Reading

1. Paul A. Longley, Michael F. Goodchild, David J.Maguire, and David W, Rhind. (2001). Geographic Information Systems and Science. London: John Wiley and Sons Limited.
2. Ian Heywood, Sarah Cornelius, Steve Carver. (1998). An Introduction to Geographical Information Systems. London: Longman Publications <http://www.awi-he.com>.
3. Burrough, P.A. (1988). Principles of Geographic Information System for Land Resources Assessment (Monograph on soil Resources Survey No.12). Oxford: Claredon Press.
4. Legg, C.A. (1992). Remote Sensing and Geographic Information Systems. London: Ellis Horwood.
5. Campbell, J.B. (1986). Introduction to Remote Sensing. London: The Guilford Press.

Additional Reading

1. Engaman, E.T and Gurney, R.J. (1991). Remote Sensing in Hydrology. London: Chapman and Hall.

Date: Janaury 31, 2017

Module Code & Title : **DOS405 Bridge Engineering and Design**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Tshewang Nidup and Mrs. Monika Thapa**
Module Coordinator : **Mr. Tshewang Nidup**

General Objective:

This module introduces the fundamental concepts and practice of Bridge design and construction. Students will be introduced to the various types of bridges and their design concepts, the various materials available for bridge construction and their respective pros and cons. Students will also be exposed to issues related to the economy, constructability, operation and maintenance aspect of the various bridge systems. Student will also learn the techniques, systems and design aspects of the traditional bridges in the country.

Learning Outcomes:

On completion of the module, students will be able to:
1. Suggest appropriate solutions based on site, geometric, functional and aesthetic requirements.
2. Determine the design loads for the various components of the bridge.
3. Design reinforced concrete deck girder bridges.
4. Design steel girder and truss bridges.
5. Design various sub structures for bridges.
6. Recommend bearing systems for bridge decks.
7. Apply prestressed concrete concepts in bridge design.
8. Design components of long span bridges – tower, anchors cables.
9. Design key components of traditional bridges.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Independent study	4	60
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-IV Term Test II: in 10th week, Unit V-VIII	2	20	30
1.2	Assignment I: in 6th week, Unit III-IV (Design of reinforced concrete and steel bridges). - Conceptual Understanding : 2 - Application of the Concept : 2 - Accuracy and correctness : 1 Assignment II: in 12th week Unit VI-VII	2	10	

	(Design of long span bridges). - Conceptual Understanding : 2 - Application of the Concept : 2 - Accuracy and correctness : 1			
2	Semester End Examination: 3 hours, closed book.	1	70	70

Prerequisites: TSM203 Structural Mechanics-I, TSM304 Structural Mechanics II, DOS302 Design of Reinforced Concrete Structures-I, DOS404 Design of Reinforced Concrete Structures-II

Subject Matter:

Unit I: Introduction and General Consideration

1.1. Types of bridges – Material, Structural form, Geometry, Function.
1.2. Selection of suitable types of bridges – Span, Function, Site condition, Economy.

Unit II: Design Loads/Stress and Analysis

2.1 Types of Load.
2.2 Loading Class – MORTH (Ministry of Roads, Transport, Highways)/ IRC standards.
2.3 Load Combination.
2.4 Influence Line.
2.5 Load and stress distribution.

Unit III: Reinforced Concrete Bridges

3.1 Design of Deck Slab Bridge.
3.2 Design of Girder Bridges.
3.3 Introduction to balanced cantilever concrete bridge.
3.4 Introduction to Reinforced Concrete Arch Bridge.

Unit IV: Steel Bridges

4.1 Plate Girder Bridge.
4.2 Truss Bridge – Through and Deck.
4.3 Fatigue behavior of steel bridges and connections.
4.4 Means of improving fatigue performance of steel bridges.
4.5 Design of Connection, Weld and Bolt.

Unit V: Prestressed Concrete Bridges

5.1 Pre-stressed concrete concept and application.
5.2 Design equations.
5.3 Cable design.
5.4 End block design.
5.5 Design of continuous beam.
5.6 Design concept and construction methods.

Unit VI: Substructure for Bridges

6.1 Different types of foundations.
6.2 Choice and method of construction.
6.3 Design of piers and abutments.
6.4 Types of bearings and design.

Unit VII: Long Span Bridge

7.1 Introduction to cable stayed bridges.
7.2 Introduction to suspension bridges.
7.3 Features - cables, tower, hangers, anchor, deck.
7.4 Design consideration.
7.5 Aerodynamic consideration.

Unit VIII: Bridge Construction Management and Maintenance

8.1 Different construction methods.
8.2 Equipment.
8.3 Fabrication and erection.
8.4 Inspection, assessment and strengthening; technical approval procedures.
8.5 Maintenance strategies, systems and procedures.
8.6 Load testing of bridges; methods of strengthening.
8.7 Durability of bridges.

Unit IX: Traditional Bridges

9.1. Baazam – feature and design.
9.2. Chazam – features and design.
9.3. Suspension and ropeways.

Reading Lists:

Essential Reading:

1. Raina V. K. Raina(2007). Concrete Bridge Practice Analysis, Design and Economics. Shroff Publishers and Distributors Pvt. Ltd. ISBN-10: 8184043783: 978-8184043785. (3ed..)
2. Victor, D.J. (1991). Essentials of Bridge Engineering. New Delhi: Oxford & IBH Publishing Co. Private Limited.
3. Raju, N.K. (1991). Design of Bridges. New Delhi: Oxford & IBH Publishing Co. Private Limited.
4. Ponnuswamy, S. (1986). Bridge Engineering. New Delhi: TMH.
5. Bakht, B. and Jaeger, L.G. (1987). Bridge Analysis Simplified. New Delhi: McGraw Hill Book Company.

Additional Reading

1. Raina, V.K. (1991). Concrete Bridge Practice. New Delhi: McGraw Hill.
2. Pama, R.P and Cusens, A.R. (1975). Bridge Deck Analysis. New Delhi: John Wiley and Sons
3. Raina. V.K (2009). Manual for Highway and Bridge Engineers. Shroff Publishers and Distributors Pvt. Ltd. ISBN-10: 8184046618: 978-8184046618 (3ed..)

4. Raina, V.K (2006). Concrete Bridges: Inspection, Repair, Strengthening, Testing and Load Capacity Evaluation. Tata McGraw-Hill Publishing Company. ISBN-10: 0074623494: 978-0074623497 (1ed..)
5. Raina, V. K. (2006). Concrete Bridge Practice: Construction Maintenance and Rehabilitation Vol.1 & 2. Shroff Publishers and Distributors Pvt. Ltd. ISBN-10: 818404805: 978-8184048056 (2ed..)
6. Raina, V. K.. Handbook for Concrete bridges Vol 2. . Shroff Publishers and Distributors Pvt. Ltd. ISBN-10: 818404805: 978-8184048056 (2ed..)
7. IRC and AASHTO Publications.

Date: Janaury 31, 2017

Module Code and Title : DOS406 Pre stressed Concrete Structures
Programme : B.E Civil Engineering
Credit : 12
Module Tutor : Tshewang Nidup

General Objective:

This module introduces the basics principles and concepts in prestressed concrete technology. Students will be introduced to the prestressing systems and method. Analysis of prestressed concrete member and design of members will help students appreciate the significance and application of the techniques in a wide range of modern civil engineering infrastructures.

Learning outcome:

"On completion of the module, learners will be able to
1. Explain the concept of prestressed concrete, systems and methods of prestressing.
2. Differentiate the principles between reinforced concrete and prestressed concrete.
3. Calculate the different types of prestress losses.
4. Determine the initial prestressing required to obtain the design prestressed level
5. Analyze prestressedmembers
6. Design members for bending, shear and torsion
7. Determine the strength of prestressed concrete members
8. Calculate deflection and crack width and check their limits
9. Explain the technique in beams, floor, bridges and other infrastructure.

Learning and Teaching approach:

Approach	Hours per week	Total credit hours
Lecture	3	45
Tutorial	1	15
Independent study	4	60
Total		120

Assessment approach:

Sl. No.	Mode of Assessment	Nos	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-III Term Test II: in 10th week, Unit IV-VI	2	20	30
1.2	Assignment I: in 4th week, Unit II-III (Analysis and Design of members) - Conceptual Understanding : 2 - Application of the Concept : 2 - Accuracy and correctness : 1 Assignment II: in 8th week, Unit V-VI (Design for shear torsion and Deflection) - Conceptual Understanding : 2 - Application of the Concept : 2 - Accuracy and correctness : 1	2	10	
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites: TSM 203 Structural Mechanics I, TSM 304 Structural Mechanics II, DOS 302 Design of Reinforced Concrete Structures I, DOS 404 Design of Reinforced Concrete Structure II

Subject matter:

Unit I: Introduction, Systems, Materials and Codes:

1.1. Basic concept of prestressed concrete structure
1.2. Advantages of prestressed concrete structure
1.3. Pre Tensioning and Post Tensioning system
1.4. Materials and properties of prestressed structure
1.5. I.S and I.R.C specifications.

Unit II: Stresses and Pre-stress Losses

2.1 Elastic shortening loss
2.2 Frictional and Anchorage slip Losses, Steel Relaxation Loss
2.3 Creep and Shrinkage Losses

Unit III: Analysis of Members

3.1 Member under axial Load
3.2 Members under Flexure – Stress concept, Force Concept, load balancing concept
3.3 Cracking moment, Kern point and Thrust Line.
3.4 Rectangular Section
3.5 Flanged Section
3.6 Partially Pre stressed Members

Unit IV: Design of Members:

4.1 Demand Calculation
4.2 Design for Axial Tension
4.3 Design for Flexure : Type I member, Type 2 member
4.4 Section choices
4.5 Magnels Graphical method
4.6 Detailing for flexure members

Unit V: Analysis and design for Shear and Torsion

5.1 Analysis for Shear, Design for Shear
5.2 Analysis for Torsion, Design for Torsion

Unit VI: Calculation for Deflection and Crack width:

6.1 Deflection calculation
6.2 Limits to span to effective depth
6.3 Calculation of Crack Width
6.4 Limits on crack width

Unit VII: Transmission of Prestress

7.1 Transmission in Pre Tensioned Members
7.2 Transmission in Post Tensioned Members

Unit VIII: Continuous and Cantilever Beams

8.1 Cantilever beams analysis ad tendon profile
8.2 Continuous Beam analysis and Tendon profile
8.3 Concordant tendon profile
8.4 Moment Redistribution

Unit IX: Special Topics

9.1 Composite Section
9.2 One way Slab, Two way slab
9.3 Compression members
9.4 Circular Prestressing

Reading list:

Essential Reading

1. Lin, T. Y. and Burns, N.H., (1982), “Design of Prestressed Concrete Structures”, John Wiley and Sons.
2. Nilson, A.H., (1978), ”Design of Prestressed Concrete”, John Wiley and Sons.
3. Naamam, A.E., (1982), ” Prestressed Concrete Analysis and Design”, McGraw Hill Publishing Company,
4. Raju, N.K., (2007), ” Prestressed Concrete”, Fourth Edition, McGraw Hill Publishing Company,
5. Pandit G S and Gupta S.P ”prestressed concrete”

Additional Reading

1. Dayaratnam, P., (1991),” Prestressed Concrete Structures”, Oxford and IBH Publishing co. Pvt. Ltd, New Delhi

2. IS 1343 2012 Prestressed concrete — code of practice
3. ACI 318-05-Building Code Requirements for Structural Concrete
4. PCI Design Handbook and PCI manual Design Handbook

Date: Janaury 31, 2017

Module Code & Title : **EVE404 Water Resources Planning and Management**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Leki Dorji**

General Objective:

This module aims to provide knowledge and skills with regard to proper planning and management of water resources. Students will also be familiarised with policies and regulations related to water use and management.

Learning Out Come:

On completion of the module, students will be able to:
1. Analyse the problems of water management.
2. Execute better water planning, practices and management.
3. Estimate the precipitation.
4. Determine different water needs and project formulations.
5. Estimate the peak flood characteristics by different methods.
6. Identify the appropriate water management methods.
7. Assess the water resources of the country.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Written assignment	2	30
Independent study	2	30
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week, Unit I-II Term Test II: in 10th week, Unit III	2	20	30
1.2	Assignment I: in 4th week, Unit I (Analyse on solving problems related with Assessment of water resources of our country and scope of water and its environments). • Correct formulae used • Methods/steps/procedure • Correct results Assignment II: in 8th week, Unit II(Determine planning for single and Multipurpose water Projects, Cost benefit ratio, Monitoring of water quality and quantity). • Correct formulae/Introduction • Methods/steps/procedure • Correct results/Conclusion	2	0.5 1.5 0.5 0.5 1.5 0.5	
2	Semester End Examination: 3hour, closed book.	1	70	70

Pre-requisites: EVE301 Hydrology

Subject Matter:

Unit I: Introduction

1.1 Role of water in national development.
1.2 Assessment of water resources of country.
1.3 Scope of water resourcesdevelopment vis-à-vis environment.

Unit II: Planning

2.1 Water resources planning process.
2.2 Planning for single purpose and multipurpose projects.
2.3 Estimation of different water needs and project formulations.
2.4 Comparison of alternatives.
2.5 Cost-benefit analysis.
2.6 Introduction to optimization techniques and systems approach.

Unit III: Management

3.1 Evaluation and monitoring of water quantity and quality.
3.2 Managing water distribution networks for irrigation, flood control and power generation.
3.3 Inter-basin transfer of water.
3.4 Conjunctive use of surface and ground water.
3.5 Water quantity and quality modelling.

3.6 Evaluation of impacts of water resources projects on river regimes.
3.7 Environment, reservoir sedimentation and watershed management.
3.8 Water sharing and dispute resolution

Unit IV: Water Policies and regulations

4.1 Water Act of Bhutan, its principles, water user's association
4.2 Specific Requirements and Procedure for Various Water Uses
4.3 Principles of Water Resources Development and Management, Water Resources Development, Water Resources Protection, flood control and management
4.4 Water User Interests and Priorities, Allocation of Water, Water for Drinking and Sanitation, Water for Food Production and hydropower

Reading Lists:

Essential Reading

1. Goodman, A.S. (1984). Principles of Water Resources Planning. New Jersey: Prentice Hall Inc.
2. Modi, P.N. (1994). Irrigation Water Resources and Water Power Engineering. New Delhi: Standard Book Company.
3. Dandekar, M.M. and Sharma, K.N. (1994). Water Power Engineering. New Delhi: Vikas Publishing Company.
4. Deshmukh M.M. (1978). Water Power Engineering. New Delhi: DhanpatRai& Sons.
5. Punmia, B.C &Pande, B.B. (1990). Irrigation and Waterpower Engineering.New Delhi: Standard Publisher and Distribution.

Additional Reading

1. Majumdar D. K. (2004). Irrigation Water Management Princip
2. les and Practice. Prentice
3. Michael A.M. (2008). Irrigation: Theory and Practice (2nd Edition). Vikas Publishing House Pvt. Ltd, New Delhi. Hillel Daniel (1998). Environmental Soil Physics (1st edition). Academic Press
4. Linsley, R.K., and Franzini, J.B. (1979). Water Resources Engineering. New

Date: Janaury 31, 2017

Module Code & Title : **EVE405 Environmental Geo-technology**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mrs. Chimi Wangmo, Mr.Karma Tempa, Mr.Ugyen Dorji**
Module Coordinator : **Mrs. Chimi Wangmo**

General Objective:

The aim of this module is to explain fundamental study on Environmental Geo technology covering geo synthesis, types of waste and its properties, disposal, landfills and hazardous waste, subsurface contamination, reuse of waste material and its regulations both at international and local level.

Learning Outcomes:

On completion of the module, students will be able to:
1. Explain methods of waste generation and subsurface contamination.
2. Investigate sub surface contamination.
3. Indentify appropriate site disposal of hazardous wastes.
4. Identify the components of landfills.
5. Analyze complex and ill-defined technical issues of environmental geotechnology
6. Identify appropriate liner materials for landfill.
7. Identify remedial measures for geotechnical contamination.
8. Evaluate the reuse of waste materials and fills.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Case studies	2	30
Independent study	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I:in 5th week, Unit I-III Term Test I:in 10th week, Unit IV-VI	2	20	30
1.2	Assignment I: 6th week, Unit I-III Analysis of issues of environmental geo-technology: 1.25 Identify remedial measures for sub-surface contamination: 1.25	1	5	
	Assignment II: in 12th week, Unit IV-VIII Introduction on geosynthetics: 0.5 Explanation on types: 1 Functions of each types: 0.5 Application: 0.5	1	5	

2	Semester End Examination: 3hours, closed book.	1	70	70

Prerequisites: EVE403 Environmental Engineering-II, FED302 Soil Mechanics

Subject Matter:

Unit I: Introduction

1.1 Scope; Importance.
1.2 Waste generation; subsurface contamination.

Unit II: Forms of Waste and their Engineering Properties

3.1 Municipal waste, mineral waste, industrial waste, hazardous waste.
3.2 Index Properties; Strength, compressibility and permeability of municipal waste and mineral waste.

Unit III: Selection of Waste Disposal Sites

4.1 Factors effecting site selection.
4.2 Siting criteria and siting rating method.

Unit IV: Landfills for Municipal and Hazardous Waste

5.1 Components of landfills; layouts; Daily cells; Basal lining systems.
5.2 Stability of slopes; Construction aspects.

Unit V: Liner Materials

2.1 Types of geosynthetics.
2.2 Applications and economics.

Unit VI: Ash Ponds and Tailing Dams

6.1 Slurry deposition of mine tailing and coal ash in impoundments.
6.2 Layout, components.
6.3 Design of tailing dams/ash dykes; Slope Stability.

Unit VII: Geotechnical reuse of Waste Materials and Fills

9.1 Use of waste material in embankments, abutments and fills for low lying areas.

Unit VIII: Regulations

11.1. Regulations governing solid waste disposal and ground water contamination.

Reading Lists:

Essential Reading

1. Owesis, I.S and Khera, R.P. (1998). Geotechnology of Waste Management. London: Butterworths.
2. Daniel, D.E. (1993). Geotechnical Practice for Waste Disposal. London: Chapman and Hall, London.
3. Gulhati,S.K and Datta,M (2005). Geotechnical Engineering. Tata McGraw-Hill Education. ISBN: 0070588295, 9780070588295. (Latest ed)
4. Rao, G.V. (1990). Erosion Control with Geosynthetics. New Delhi: C.B.I.P.
5. Vick, S.G. (1990). Planning, Design and Analysis of Tailing Dams. New York: John Wiley.

Additional Reading

1. Rao, G.V., and Raju, G.V.S.S. (1990). Engineering with Geosynthetics. New Delhi: TMH.
2. Zaruba, R. and Mencl, V. (1992). Landslides and their Control. Berkeley: Elsevier Science.
3. Goumans, J.J.M., Vanderstoot, H.A., and Alberts, T.G. (1994). Environmental Aspects of Construction with Waste Materials. New York: Elsevier Science.
4. Valdiya, K.S. (1998). Environmental Geology - The Indian Context – Chapter 11-Instability of Hill Slopes and Landslides. New Delhi: TMH.
5. Bromhead, E.N. (2007). The Stability of Slopes. London: Chapman and Hall.
6. Bhutan state of the environment report(2016). National Environment Commission. Royal Government of Bhutan. Post Box No:466, Thimphu Bhutan. www.nec.gov.bt

Date: Janaury 31, 2017

Module Code & Title : **HWE402Traffic Engineering**
Semester : **BE Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Sangey Pasang and Ms. Yeshi Choden**
Module Coordinator : **Mr. Sangey Pasang**

General Objective:
This module provides the fundamentals of traffic characteristics study, facilities design, operation and safety, transportation system analysis, management and covers tools for road network design.

Learning Outcomes:

On completion of the module, students will be able to:
1. Use appropriate technique to analyse the fundamental theories of traffic flow.
2. Analyse and design the collections of data for traffic design purposes.
3. Design traffic control systems at intersections and highway geometry layouts for safe and efficient management of traffic.
4. Solve complex problem by investigation and integration of knowledge in traffic engineering.
5. Describe basic concepts underlying methods for predicting the demand for transport.
6. Evaluate the pattern of movement in a transport network and the economic assessment of transport projects.
7. Identify basic techniques for assessing and ameliorating some of the environmental effects of traffic (accidents, traffic noise).

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Written assignment	2	30
Independent study	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment			
1.1	Term Test I: in 5th week, Unit I-II Term Test II: in 10th week, Unit III-IV	2	20	30
1.2	Assignment I: in 6th week, Unit I-III Collection of traffic data:1.0 Traffic Data analysis: 1.5 Traffic Design: 3.5. Assignment II: in 11th week, Unit IV-V Literature review: 1.0 Analysis of traffic control system: 3 Point out the environmental effect of traffic: 1.0	2	10	

2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites: HWE 401 Highway Engineering

Subject Matter:

Unit I: Introduction

1.1 The 3E's of traffic engineering (Education, Engineering and Enforcement).
1.2 Problems due to mixed traffic and other conditions in developing countries.

Unit II: Traffic Characteristics

2.1 Road user characteristics, Vehicular characteristics, Traffic flow characteristics.
2.2 Capacity, Traffic studies, Volume, Spot speed, Speed.
2.3 Delay, Origin and destination, Parking and accidents.

Unit III: Traffic Facilities Design

3.1 Design of intersection – rotary intersections, grade separated intersection.
3.2 Design of off- street parking facilities.

Unit IV: Traffic Operation and Safety

4.1 Traffic regulation, Controls on vehicles, Drivers and flow, one way street tidal flow operation, priority of high occupancy vehicles.
4.2 Traffic control devices – signs, signals, Islands and markings. Design of isolated traffic signals by IRC method.
4.3 Analysis of traffic accidents, Highway lighting, Effect of road conditions.
4.4 Road geometrics on traffic safety, Traffic safety awareness.

Unit V: Traffic and Environment

5.1 Pollution problems of cities, Noise pollution, Air pollution, Vibration.
5.2 Environmental Impact Assessment, mitigative measures.

Reading Lists:

Essential Reading

1. Mcshane, W.R., and Roes, R.P. (2004). Traffic Engineering. New Jersey: Prentice Hall.
2. Flaherty, CAO. (2004).Transport Planning and Traffic Engineering. New York: John Wiley and Sons Inc.
3. Slinn,M.Mathews,P. and Guest, P.(2012). Traffic engineering Design. Principles and practices. Taylor & Francis.(2 ed).
4. Roess,R.P, Prassas, ES, McShane, W.R (2010).Traffic Engineering. Pearson;ISBN: 0136135730: 978-0136135739.(4 ed,.)
5. Flaherty,C.A.O (Transport Planning and Traffic Engineering. (1996). Elsevier. ISBN:9780340662793.(1 ed,.)

Additional Reading

1. Kadiyali, L.R. (2004). Traffic Engineering and Transport Planning. Delhi: Khanna Publishers.
2. May, A.D. (2005). Traffic flow Fundamentals. New Jersey: Prentice Hall.

Date: Janaury 31, 2017

Module Code &Title : **BPD404 Sustainable Building Planning and Design**
Programme : **BE in Civil Engineering**
Credit : **12**
Module Tutor : **Mr. Dhrubaraj Sharma**

General Objective:

The module aims to provide study on building typology, impact of building industry on environment, green building materials, pre design for sustainability, planning and design, site development, energy efficiency in design and green building management of structures.

Learning Outcomes:

On completion of the module, students will be able to:
1. Differentiate the typologies of building.
2. Analyze the impacts of building industry on environment.
3. Evaluate the lifecycle of a building.
4. Differentiate sustainable building materials and their source of extraction.
5. Approaches in the design of sustainable buildings and building components.
6. Analyze cost effective building design and its maintenance in projects.
7. Apply the solar passive, cooling & thermal concepts to design a building.
8. Formulate sustainable design components in different types of buildings.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Written assignment	2	30
Independent study	3	45
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos	Marks Allocated	Marks (%)
1	Continuous Assessment			
1.1	Term Test I: in 5th week,Unit I-II Term Test II: in 10th week, Unit III-IV	2	20	30
1.2	Assignment I: in 6th week,Unit III (Evaluate the lifecycle of a building). Criteria for assessment of assignments I • Data collection : 2 • Data presentation : 2 • Referencing : 1	1	5	

1.3	Assignment II: in 12th week, Unit VI (Apply the solar passive, cooling & thermal concepts in building design). Criteria for assessment of assignments II • Climate analysis : 2 • Design presentation : 3	1	5	
3	Semester End Examination: 3 hours, closed book.	1	70	70

Prerequisites: None

Subject Matter:

Unit I: Basic Concept of Building Typology

1.1 Typology and the classification of characteristics commonly found in buildings.
1.2 All important aspects throughout the entire building cycle.
1.3 Introduction of the basic principles of building design.

Unit II: Impact of Building Industry on Environment:

2.1 Depletion of Earth's resources, minerals and energy, towards anthropogenic Climatic changes towards hotter and drier climates.
2.2 Desertification, Coastal flooding and erosion.
2.3 Water shortage – decline in water quality, Food security- threatened.
2.4 Imbalance in Eco system.

Unit III: Green Building Materials

3.1 Definition of a green building, need for green buildings in Bhutan.
3.2 Aims of green building, pros and cons of green buildings.
3.3 Economic benefits of green building.
3.4 Green building materials and long life buildings.

Unit IV: Pre Design for Sustainability & Planning and Design

4.1 The design and building project.
4.2 Passive solar design with local climatic considerations.
4.3 Building shape and orientation.

Unit V: Building and Site Development

5.1 Site analysis, climate analysis.
5.2 Sustainable landscaping.
5.3 Sustainable parking design.
5.4 Storm water management.

Unit VI: Energy Efficiency in Design

6.1 Passive solar heating, passive solar cooling
6.2 Thermal storage, materials and finishes for effective lighting.
6.3 Integration of natural daylight into buildings.

Unit VII: Green Building Management

7.1 Indoor environmental quality, water conservation measures.
7.2 Sustainable operation and maintenance strategies.
7.3 Protection of the site during construction.
7.4 Environmentally sensitive construction practices.

Reading Lists:

Essential Reading

1. Merritt, F. S. and Ricketts, J. T. (2001). Building Design and Construction Handbook (6ed.).New York: McGraw Hill.
2. Ahuja, T.D., and Birdie, G.S. (1996). Fundamentals of Building Construction. New Delhi: Dhanpat Rai Publishing Company Private Limited.
3. Galloe, Salam., and Sayigh, A.M.M. (1998). Architecture, Comfort and Energy. Oxford: Elsivier Science Ltd.
4. De Chiarra, Joseph., and Copplemann, L. (1983). Planning and Design Criteria (1 ed.). New York: McGraw-Hill.
5. Lstiburek, J.W. (2000). Builder's Guide: Hot-humid Climates, Building Science Corporation. MA: Westford.

Additional Reading

1. Amundsen, and H.Dunin-Woyseth. In Traditional Dwellings and Settlements Working Paper Series Vol.67/IASTE, CEDR. Berkeley: University of California.
2. Ministry of Works & Human Settlements. (2013). An Introduction to Traditional Architecture of Bhutan.
3. Ministry of Works & Human Settlements. (2002). Bhutan Building Rules.
4. Ministry of Works & Human Settlements. (2009). Attic Rules.
5. Ministry of Works & Human Settlements. (2004). Thimphu Structure Plan.

Date: Janaury 31, 2017

Module Code & Title : HWE403 Slope Stability on Mountain Roads
Programme : BE in Civil Engineering
Credit : 12
Module Tutor : Mr. Tshering Tobgyel and Mr. Sangey Pasang
Module Coordinator : Mr. TsheringTobgyel

General Objective:

The module aims to integrate concepts & principles focus on slope stability study of landslides and mountain roads, site investigation, design and construction and slope management.

Learning outcomes:

On completion of the module, students will be able to:

1. Carry out feasibility studies, planning, site investigation, desktop study and field mapping.
2. Identify the causes and mechanisms of slope stability.
3. Analyse and identify problems affecting roads in hilly and mountainous area.
4. Design route alignment, slope, retaining structure, drainage and erosion protection works.
5. Respond to slope and retaining wall failures that occur during road operation.
6. Able to explain component of slope management.
7. Carryout various slope planning and maintenance.
8. Carry out risk management and prioritization for maintenance procurement.
9. Carry out slope inspections and road maintenance and operation.

Learning and Teaching Approach:

Approach	Hours per Week	Total Credit Hours
Lecture	3	45
Tutorial	1	15
Independent study/self-directed learning	4	60
Total		120

Assessment Approach:

Sl. No.	Mode of Assessment	Nos.	Marks Allocated	Marks (%)
1	Continuous Assessment (Theory)			
1.1	Term Test I: in 5th week,Unit I-II Term Test II: in 10th week,Unit III-IV	2	10	30
1.2	Assignment I: in 4th week, Unit II (seminar on Analyses and identifying problems affecting roads in hilly and mountainous area). • Report Submission =1 mark • Problem identification=1mark • Analysis= 1 mark • Solution to problem=1mark • Presentation=1mark	1	5	
1.3	Assignment II: in 8th week, Unit III (Mini project work on design route alignment, slope, retaining structure, drainage and erosion protection works). • Report Submission =1 mark • Problem identification=1mark • Analysis= 1 mark • Solution to problem=1mark • Presentation=1mark	1	5	
2	Semester End Examination: 3 hours, closed book.	1	70	70

Pre-requisites: HWE401 Highway Engineering, FED302 Soil Mechanics

Subject Matter:

Unit I: Introduction

1.1 Introduction to Landslides and mountain Roads, Low-volume and low-cost roads
1.2 Project Phasing and procurement in relation to slope management
  1.1.1 Project phasing.
  1.1.2 Common forms of contract-price-based, rates-only, directly employed labour by force-account.
  1.1.3 Labor-based and local resource-based approaches.
1.3 Slope materials, landslide causes and landslide mechanisms
  1.3.1 Common soil types and their influence on slope stability.
  1.3.2 Common rock types and structures and their influence on slope stability.
  1.3.3 Outline of the causes of landslides.
  1.3.4 Landslide types and characteristics.
  1.3.5 Landslide displacement.
  1.3.6 Landslide impacts on roads.
  1.3.7 Case studies.
1.4 Landslide risk management for mountain roads.
  1.4.1 Decision-making
  1.4.2 Landslide Susceptibility, Hazard and Risk.
  1.4.3 Risk management.

Unit II: Site Investigation

2.1. Scope and Programming
  2.1.1. Range of techniques
  2.1.2. Programming of techniques
2.2. Desk Studies
  2.2.1. Traditional data sources
  2.2.2. Airborne imagery
  2.2.3. Satellite image interpretation
  2.2.4. Terrain models
  2.2.5. Terrain classification
  2.2.6. Landslide susceptibility, hazard and risk maps
  2.2.7. Geographical information systems (GIS) applications
2.3. Field Mapping
  2.3.1. Reconnaissance surveys
  2.3.2. Reference condition mapping
  2.3.3. Landslide hazard mapping
  2.3.4. Engineering geological mapping
2.4. Ground investigation
  2.4.1. Purpose of a ground investigation
  2.4.2. Scope of investigation
  2.4.3. Investigation methods
  2.4.4. Supervising a ground investigation
2.5. Slope movement monitoring
  2.5.1. Purpose
  2.5.2. Monitoring methods
  2.5.3. Interpretation of surface monitoring data
  2.5.4. Assessing depth of slope movement from monitoring data

Unit III: Design and Construction

3.1 Route corridor and alignment selection:
  3.1.1. Controlling factors
  3.1.2. Route corridor identification and selection

3.1.3. Alignment and carriageway design
3.1.4. Case studies

3.2 Earthworks
3.2.1. Choice of cross-section
3.2.2. Design of cut slope angle
3.2.3. Choice of cut slope profile
3.2.4. Fill slopes
3.2.5. Earthworks balance
3.2.6. Spoil disposal

3.3 Soil slope stabilization
3.3.1. Distinction between soil and rock
3.3.2. Soil slope stability assessment and analysis
3.3.3. Soil slope stabilization
3.3.4. Slope failure type 1: cut slopes
3.3.5. Slope failure type 2: fill slopes
3.3.6. Slope failure type 3: Above-road slopes
3.3.7. Slope failure type 4: below-road slopes
3.3.8. Slope failure type 5: failure of the entire slope

3.4 Rock slope stabilization
3.4.1. Controls on rock slope stability
3.4.2. Assessing rock slope stability
3.4.3. Managing rock slope stability along mountain roads
3.4.4. Stabilization measures
3.4.5. Protection measures
3.4.6. Case studies

3.5 Retaining structures
3.5.1. Types of retaining structure
3.5.2. Design of retaining walls
3.5.3. Selection of wall cross-section
3.5.4. Wall backfill and drainage
3.5.5. Retaining wall construction

3.6 Slope and Road Drainage
3.6.1. The importance of drainage
3.6.2. Slope drainage
3.6.3. Road drainage

3.7 Erosion control
3.7.1. Sources of erosion
3.7.2. Slope erosion control
3.7.3. Stream erosion control
3.7.4. Culvert outlets
3.7.5. Slope toe protection and river training
3.7.6. Debris flow control and debris fan crossings

Unit IV: Slope Management

4.1 Components of slope management
4.2 Planning slope maintenance
4.3 Categories of slope maintenance
4.4 Inspection
4.5 Risk management
4.6 Prioritization
4.7 Maintenance procurement

Reading Lists:
Essential Reading

1. Hearn, G.J. (2011). Slope Engineering for Mountain Roads. London: Geological Society, Engineering Geology Special Publications.
2. Khanna, S.K., & Justo, C.E.G. (2003). Highway Engineering. Roorkee: Nem Chand & Bros.
3. ChennaKesavulu, N. (2003). Textbook of Engineering Geology. New Delhi: Maxmillan Publishers India Ltd.
4. Chaudhry, B. (2009). Location of Roads in Hilly & Mountainous Country. Indian Road Congres, Vol. XXIII-3 & 4
5. Wyllie,D.C& Mah,C.W(eds)2004.Rock slope engineering 4t edn, Taylor and Franis, Suffolk.

Additional Reading

1. Kanithi, V. (2012). Engineering Geology. Hyderabad: Universities Press.
2. Soam, S.K., Sreekanth, P.D. & Rao, N.H. (2013). Geospatial Technologies for Natural Resources Management. New Delhi: New India Publishing Agency.
3. Davis, C.J. (2014). Statistics and Data Analysis in Geology. New Delhi: Wiley India.
6. Dunning, S.A., Massey, C.I & Rosser, N.J. (2009). Structural Ad Geomorphological Features of Landslides in Bhutan Himalaya Derived from Terrestrial Laser Scanning. Geomorphology, 103, 17-29
7. Eddleston, M.,Walthall S., Cripps J. C., &Culshaw M. G. (2004). Engineering Geology of Construction. London: Geological Society, Engineering Geology Special Publications.

Date: Janaury 31, 2017