Semester I

Name of the Module	**:**	Engineering Mathematics-I
Module Code	**:**	MAT101
Semester	**:**	I
Credit Value	**:**	12
Module Leader	**:**	Mr. Sangay Lungten
Module Tutor	**:**	Mr Sangay Lungten and Jayachandran V

General objectives or aims of the module:

This module is a key element of any Engineering degree programme. It introduces students to mathematical techniques that support engineering modules and provides methods for analysis of practical engineering problems. To develop the student's ability to formulate engineering problems in terms of mathematical model and to interpret the solution

Learning outcomes:

Upon successful completion of this module, the students will be able to

1. Differentiate a function successively and also able to apply Leibnitz's theorem to find the nth derivative of the function.
2. Apply appropriate Mean Value Theorems to expand the given function.
3. Identify the indeterminate form and evaluate the Limits.
4. Use Partial Differentiation to find the Jacobians of functions of two or more variables and expand the two variable functions by Taylor's series.
5. Appreciate the application of partial differentiation to find the Maxima and Minima of functions of two variables.
6. Use Reduction formula to find the Integral and Definite Integral of functions. They will also have knowledge of geometric applications of the methods presented.
7. Apply appropriate methods to test the Convergence and Divergence of different infinite series.
8. Solve Differential Equations of first order first degree and first order higher degree.
9. Determine the Rank of a Matrix, and to solve Simultaneous Equation by Matrix method.
10. Enhance the problem solving skills through the subject material.

Learning and teaching approach used:

- Lectures : 4 hrs/week
- Tutorial : 1 hr/week

Assessment:

Continuous Assessment - 30 marks (30%)

1. Assignment - 10marks
2. Closed book mid Term Test- 15marks
3. Class Test - 5marks

Semester End Examination - 70marks (70%)

1. Written examination 3 hrs -(closed book)

Subject matter

1. **Differential Calculus:** Differential calculus -Successive differentiation and Leibnitz's Theorem; Mean Value Theorems -Rolle's, Lagrauge's , Cauchy's; Higher mean value theorem or Taylor's development of functions in a finite form- with Langrange's form of reminder, Maclaurin's development of f(x) with Langrange's form of reminder and Taylor's development of a function with Cauchy's form of reminder; Indeterminate form and Evaluation of limits -0/0 form, ∞/∞, $0\times\infty$,other forms; Expansions- Taylor's Infinite Series, Convergence of Infinite series and Maclaurin's Infinite Series; Partial Differentiation- Functions of two variables, Continuity in a domain, Limit of a function, Limit of a continuous function, Partial derivatives and partial derivatives of higher order, Homogenous functions and Euler's theorem of Homogeneous functions, Choice of Independent variables, Theorem of total differentials, Composite functions and theorem of composite function, Implicit functions (Typical cases), Error determination, Jacobian's and Taylor's series of two variables; Applications of Partial Differentiation- Maxima and Minima- Langrange's method of undetermined multipliers, Differentiation under the Integral sign- Leibniz Rule.
2. **Integral Calculus:** Definite Integral as the limit of sum; Reduction formula; Application of Length, Area, Volume, Surface area of revolution, Moments and centre of gravity.
3. **Infinite Series:** Introduction, Definitions, Convergence, Divergence, and Oscillation of a series. General properties of a series, Series of positive terms, Comparison test, Integral test, Comparison of ratios, D'Alembert's ratio test, Raabe's test, Logarithmic Test, Logarithmic Test, Cauchy's root test, Alternating Series, Leibnits Rule, Series of positive or negative terms, Power series, Convergence of Exponential, Logarithmic and Binomial series, Procedure for testing Series for convergence, Uniform convergence, Weirstrass's M-Test, Properties of uniform convergence of a series.
4. **Differential Equations:** Introduction, Definition, degree, Order and solution of a differential equation. First order First Degree Equations, Variable separable, Homogeneous Equation, Equation reducible to Homogeneous, Linear differential equation, Bernoullis form, Exact differential equation, Equation of first order and higher degree.
5. **Matrices and Determinants:** Definition and elementary operations, Addition, subtraction and multiplication of matrices, Determinants, Expansion of determinants, Properties of determinants by counter examples, Minors and co-factor of a determinant, Determinant of a square Matrix, Adjoint of a square matrix, Matrix inverse, Solution of simultaneous equation by Matrix method, Rank of a matrix, Elementary transformation of a matrix.

Reading list:

1. Erwin Kreyszig (8th edition). *Advanced Engineering Mathematics*. Wiley Student Edition.
2. Dr. Grewal, B.S. (40th edition-2007). *Higher Engineering Mathematics.* New Delhi: Khanna Publishers
3. Das, H.K (14th edition-). *Higher Engineering Mathematics.* New Delhi: S. Chand
4. Prasad, I.B. *Practical Mathematics*.
5. Jain, R.K. and Iyengar S.R.K. *Advanced Engineering Mathematics*. New Delhi: New Age International
6. Balachandra Rao, S and Anuradha, H.R. *Differential Equations with Application and Programmes*.
7. Vasishtha, A.R. *Matrices*.

Date: June 2011

Name of the Module	**:**	Engineering Physics – I
Module Code	**:**	PHY101
Semester	**:**	I
Credit value	**:**	12
Module leader	**:**	Mr. Rajesh Subedi
Module Tutor	**:**	Mr. Rajesh Subedi and Mr.Kelzang Dorji

General objective:

This module will provide students with fundamental understanding of physics and the engineering knowledge work for a variety of technical position. This will facilitate student learning through use of appropriate activities, and technology and the illustration of physics applications in the real world.

Learning outcomes:

At the end of this module, students are expected to 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 one and two dimensions
4. Calculate the forces related to position, velocity and acceleration using Newton's law.
5. Explain the concept of work-energy theorem
6. Describe momentum and conservation of linear and angular momentum
7. Analyse the formation of waves on stretched string
8. Explain the nature of light and describe interference
9. Analyse the results of observed practical experiments
10. Analyse the relationship between graphs and equations and how they represent physical situation.
11. Analyse the crystalline nature of solids.

Learning and teaching approach used:

- Lectures : 4 hours per week
- Practical : 2 hours per week
- Self study : 7 hours per week

Assessment:

- **Theory – 75 marks**
  Continuous assessment 25 marks
  1. Assignment - 10marks
  2. Closed book mid Term Test - 10marks
  3. Class Test - 5marks

  Semester End Examination – 50 marks
  1. Written examination (Closed books): 3 hours.

- **Practical continuous Assessment - 25 Marks**
  1. Regular Laboratory work – 15 marks as shown in annexure - I
  2. Viva/test – 10 marks

  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%.

Subject matter:

1. **Revision of Mathematical tools applied to Physical problem:** Units and their conversion; Vector operations in Cartesian and plane polar co-ordinates with physical examples; Function plotting with physical examples; Not derivation of the equations to be done.
2. **Kinematics**: Need of frames of reference in describing motion; One Dimensional motion; Two dimensional motion; Velocity and acceleration in polar coordinates.
3. **Dynamics:** Survey of common forces in nature; Newton's laws of motion, The need of First law in defining inertial frames; Work-Energy Theorem, Conservation and non- conservative forces, potential energy; Conservation of linear momentum, variable mass problems; Angular momentum and its conservation; Central forces, Inverse square force; Oscillations, General potential with stable equilibrium point, Solution of Differential equation with emphasis on initial conditions, Damped and forced oscillation.
4. **Waves:** Waves on a stretched string, Differential equation of wave, Description of general solution f (s$\pm$vt) Longitudinal and transverse waves; Superposition of waves, Plane monochromatic waves, $v=n\lambda$, plane, spherical and cylindrical wavefronts.
5. **Optics:** Introduction to nature of light; Interference of light; Coherent sources, Young's double slit; Thin films, Michelson's interferometer.
6. Introduction to crystalline nature of solids, Miller indices, atomic packing fraction for SC, BCC, FCC.

List of Practicals:

1. Practice of Significant digits and Errors in measurements
2. Measurement of length using screw gauge, slide calipers and travelling microscope
3. Measurement of short time intervals using electronic timer, sensors
4. Study of rotational motion of a cycle wheel
5. Study of oscillatory systems
6. Study of stationary waves
7. Use of prism spectrometer
8. Measurement of wavelength of light using Interference of light from (a) Sodium source and (b) Helium-Neon source

Reading list:

1. Resnic and Halliday Walker (2009), "Fundamentals of Physics", 8th edition, John Wiley & Sons Inc.
2. Gaur, R.K. and Gupta, S.L. (2008), "Engineering Physics", 8th edition, Dhanpat Rai Publications, New Delhi.
3. Verma, H.C. and Bhawan, Bharati (2009), "Concepts of Physics Part-I", 1st edition, (P&D), Patna.
4. Jenkins and White, (1981), "Fundamentals of Optics", McGraw-Hill Book Company, New Delhi.
5. Dr. M. Arumugam (1997), "Engineering Physics", 2nd edition, Anuradha Agencies.
6. Kleppner D.and Kow, R.J Kolen (2002), "An introduction to Mechanics", 4th edition, McGraw Hill Book Int.

Date: June 2011

Name of the Module	:	Engineering Chemistry
Module Code	:	CHE101
Semester	:	I
Credit Value	:	12
Module Leader	:	Mr. Basant Pradhan
Module Tutor	:	Mr. Basant Pradhan and Mr Baharat Humagai

General Course Objectives:
The objective of the study is to enable the students to understand the basic concepts, theories and principles of chemistry as a base of building and testing theories and practical involving in engineering chemistry. Also to apply the basic chemical concepts to problem solving and applying chemical knowledge to personal decisions involving chemical products and the development of the student's abilities to make observations and carry out measurements in the laboratory and to draw conclusions based on those observations or measurements.

Learning Outcomes
The module will enable students to:

i. get familiar with atoms, molecules, solids, thermodynamics and its application in our day to day life, phase equilibria, polymers in engineering and domestic areas, fuels, surface chemistry, nanochemistry and its applications.
ii. enhance knowledge on chemical concepts, facts and principles.
iii. apply the knowledge gained in their day to day life.
iv. follow safety measures in handling the apparatus or chemicals.
v. interpret data and make sound analysis of it.
vi. widen their horizon in their approach towards science.

Learning and Teaching Approach Used:

- Lectures : 3 hours per week
- Tutorial : 1 hour per week
- Practical : 2 hours per week
- Self study : 4 hours per week

Some of the topics will be lectured, while some will be taken up for discussion. This will enable students to get a better understanding of the subject and the topic discussed.

Assessment:

- **Theory – 75 Marks**

Continuous assessments – 25 marks

1. Assignment - 10 marks (1 No.)
2. Midterm test (closed book) - 15 marks

Semester End Examination – 50 marks

1. Written Examination (Closed books) : 3 hours

- **Practical – 25 Marks**

1. Regular Laboratory Assessment - 10 marks
2. Practical Exam (Closed Book) - 10 marks
3. Viva Voce - 5 marks

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%.

Subject Matter:

1. **Atoms:** de Broglie's formula, uncertainty principle, wave mechanics, Schrodinger equation, particles in one dimension, degeneracy, radial probability distribution functions.
2. **Molecules:** LCAO method of diatomic, hybridization (sp^3d, sp^3d^2, sp^3d^3) and molecular orbital theory. Electronic spectra of atoms and molecules.
3. **Solids:** various type of crystal lattices, NaCl, CsCl, CaF_2, TiO_2,. Metal band theory of solids, semi - conductors and insulators.
4. **Physical Chemistry:** Energetic of chemical reaction and effect of temperature. Application of thermodynamic principles to chemical reactions. Feasibility and prediction of chemical reactions. Thermodynamic calculation of equilibrium constants. Gibbs Helmholtz equation.
5. **Phase equilibria**: Application to one component system, (H_2O, S and CO_2) Two components solid - liquid system (eutectic and compound formation), freezing mixtures, liquid - liquid systems. Critical solution temperature.
6. **Polymer Chemistry:** Introduction, Classification of polymers and polymerization. Addition and condensation polymerization, chain growth and chain transfer polymerization. Free radical, cationic and anionic polymerization and their mechanism. Coordination polymerization and copolymers.Tacticity of polymers.Synthesis, properties and application of: polyethylene, polyvinyl chloride (PVC), polystyrene, phenol formaldehyde, epoxy resins, acrylonitrile butadiene styrene. Compounding of plastic (natural rubber and synthetic rubber). Synthesis, properties and application of: Styrene-butadiene rubber, Neoprene, butyl rubber, silicon rubber.
7. **Metals and Alloys:** Introduction, Physical properties of metals, Cast iron, wrought iron, steel, heat treatment of steel, Definition of alloys, purpose of making alloys, classification of alloys, alloys of steel and its application, on ferrous alloys and its industrial application.
8. **Fuels and Combustion:** Classification of fuels, Calorific value-LVC,HVC,Measurement of calorific value using bomb calorimeter(Numerical problems).Knocking and anti-knocking for petrol and diesel(Octane number and Cetane number).Petroleum, refining of petroleum by fractional distillation. Diesel index.LPG, natural gas, CNG-composition and application. Biodiesel and Biogas-composition and application.
9. **Nanochemistry:** Introduction – properties (electrical, mechanical and vibrational) – carbon nano tubes – applications in fuel cells, catalysis and use of gold nanoparticles in medicine.
10. **Surface Chemistry**
    Adsorption-Physisorption and chemisorption and their characteristics, factors affecting adsorption of gases on solids, Freundlich and Langmuir adsorption isotherms, adsorption of solutes from solutions,

List of Practicals:

1. Preparation of one organic compound.
2. Preparation of one inorganic complex.
3. Estimation of metal by complexomatric method.
4. One number of acid base titration.
5. One number of 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 List:

1. J.D. Lee (1996) , Concise Inorganic chemistry, Chapten and Hall (Blackwell Science Ltd.), London, 5th Edition
2. Gorden M.Barrow (1979) , Physical chemistry, Mc Graw Hill Ltd. , New Delhi, 4th Edition
3. Samuel Glasstone (1996), Physical chemistry, Hardcover Kriegar Publishing Company, USA, 4th Edition
4. Atkins (2001), Elements of Physical chemistry, Oxford University Press, UK, 4th Edition
5. I.L.Finer (1975), Organic chemistry Vol. I and II, English Language Book Society, Longman Group Ltd., UK, 5th Edition
6. A.I. Vogel (1978), Practical Organic chemistry, Longman Group Ltd., London, 4th Edition
7. A.I.Vogel (1978), Pratical Inorganic chemistry, English Language Book Society, Longman Group Ltd., UK, 5th Edition
8. S.S.Dara (1986), Engineering chemistry , S. Chand and Co. Ltd., New Delhi, Latest Edition
9. Jain and Jain (1993), Engineering chemistry, Dhanpat Rai Publishing Company, New Delhi, 10th Edition

Date: June 2011

Name of the Module	**:**	Engineering Graphics
Module Code	**:**	EGP101
Semester	**:**	I
Credit Value	**:**	12
Module Leader	**:**	Mrs. Pema Youden
Module Tutor	**:**	Mrs. Pema Youden and Mr. Sangay Dorji

General objectives or aims of the module:

To introduce the students to the importance of graphics in engineering, facilitate geometrical constructions and projections.

Learning outcomes:

At the end of this module, students are expected to be able to:

1. Appraise the importance and scope of engineering graphics.
2. Compute scales, dimensions of geometrical constructions.
3. Perform the projections lying in different quadrants and orientation.
4. Project the solids such as pyramids, prisms, cylinders, cones, spheres etc.

Learning and teaching approach used

- Lectures : 1 hour per week
- Practical : 6 hours per week

Assessment

Continuous assessment – 50 marks

1. Midterm exam – 5 marks
2. Assignment – 30 marks
3. Tests – 15 marks

Semester End Examination – 50 marks

Written examination – 50 marks.

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%.

Subject matter

1. **General:** Importance, Significance and scope of engineering drawing, Lettering, I.S. drawing conventions- line symbols, kinds of line, drawing sheet lay-out, rules of printing, Sense of proportioning.
2. **Size Description:** Tools of dimensioning. Size and location dimensions. Principles and conventions of dimensioning, Types of Scales and their construction and uses, Preferred scales.
3. **Projection of Points and Lines:** Introduction to planes of projection, Reference and auxiliary planes, projections of points and lines in different quadrants, traces, inclinations, and true lengths of the lines, projections on auxiliary planes, shortest distance intersecting and non-intersecting lines.
4. **Projections of Planes:** 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). Obtaining true shape of the plane figure by projection.
5. **Projection of Solids:** 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.
6. **Sections of Solids:** Importance of sectioning, principles of sectioning, types of sections, cutting plane representation, section lines, and conventional practices.
7. **Development of Surface:** Development of simple objects with and without sectioning.
8. **Projections:** Perspective, orthographic, isometric and oblique projections, isometric scale, isometric drawing. Representation in first and third angle systems of projections.
9. **Computer Aided Drafting:** Basic concepts and use of AutoCAD.

Reading list

1. Narayana, K.L. and Kannaiah, P. (2006), "Text Book on Engineering Drawing", Scitech Publications, New Delhi.
2. Bhatt, N.D. (2006), "Elementary Engineering Drawing", Charotar Publishing House. New Delhi.
3. Chandra, A.M. and Chandra Satish. (2003), "Engineering Graphics", Narosa Publishing House, New Delhi.
4. "IS: 696 (1972) Code of Practice for General Engineering Drawing", ISI New Delhi.
5. Lakshminarayanan V. and Vaish Wanar R.S.(1998), "Engineering Graphics", Jain Brothers.
6. French and Vireck (1978), "The fundamental of Engineering Drawing and Graphic Technology", 4th edition, McGraw Hill, New Delhi..
7. P.S. Gill (1980), "A Text Book of Machine Drawing", Katson Publishing House, Ludhiana.
8. Giesecke, Mitchell, Spener, Hill and Dygon (1980), "Technical Drawing", 7th edition, McMillan & Co.
9. George Omura (1994), "Mastering AutoCAD", R.P.B. Publication, New Delhi.

Date: June 2011

Name of the Module	**:**	Introduction to Programming (C)
Module Code	**:**	CPL101
Semester	**:**	I
Credit Value	**:**	12
Module Leader	**:**	Mr. Tsheten Dorji
Module Tutor	**:**	Mr. Tsheten Dorji, Mr. Yeshey Wangchuk

General objectives or aims of the module:
The objective of the module is to introduce students to programming and to cover the fundamentals of C Programming.

Learning outcomes:
At the end of this module, students are expected to be able to:

1. Identify computer logical units.
2. Customize computer hardware.
3. Write programs to solve science and engineering problems.
4. Code, run and debug programs.
5. Use software tools available for programming.

Learning and teaching approach used:

Lectures	:	2 hours per week
Tutorial	:	1 hour per week
Practical	:	2 hours per week

Assessment
Continuous assessment – 25 marks
Practical assessment – 25 marks
Semester End Examination – 50 marks

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%.

Subject matter:
1. **Introduction:** Define software, hardware, system software, application software, algorithm, program, machine language, assembly and high level languages, assembler, compiler, interpreter, editor, operating system; batch processing, multiprogramming, timesharing, define concepts of the finite storage, bits, bytes, kilo, mega, Giga bytes and concept of character representation. Compilation, linking, loading running of program on Linux.
2. **Solution Formulation:** defining the problem; structuring the solution using the top down approach; concepts of sequence, selection and iteration; Algorithm: flowchart, pseudo-code, recursive formulation of solution.
3. **Representation of Data and Basic Data Types:** Integer, characters, Endian, IEEE 754 floating point representation, ASCII, Unicode port representation.
4. **Basic constructs:** the basic format of C program; input and output; characters, numbers and strings; arithmetic and logical operators; selection statements; iteration statements.
5. **Functions:** concept of a function; programming a function; passing data to and from a function. globally, by value and by reference.
6. **Arrays:** concept of an array; writing and reading to one and two dimensional arrays; passing arrays to and from functions.
7. **Structures:** concept of a structure; simple applications of structures.
8. **Pointers:** concept of a pointer; simple applications of a pointer.

List of Practical's:

1. Demonstration of PC Hardware parts
2. Send/Receive email with attachment
3. Sequence implementation
4. Selection implementation
5. Iteration implementation
6. Function implementation
7. Array implementation
8. Structure implementation
9. Pointer implementation

Reading list

1. E.Balaguruswamy, Programming in ANSI, Tata Mc Graw-Hill.
2. Ashok N. Kamthane, Computer Programming, Pearson Education
3. Brian W. Kernighan, Dennis M. Ritchie, The C Programming Language, Prentice Hall

Date: June 2011

Semester II

Name of the Module	**:**	Engineering Mathematics-II
Module Code	**:**	MAT102
Semester	**:**	II
Credit Value	**:**	12
Module Leader	**:**	Mr. Jayachandran V
Module Tutors	**:**	Jayachandran V and S.T. Venkatesan

General objectives or aims of the module:

This module is a key element of any Engineering degree programme. It introduces students to mathematical techniques that support engineering modules and provides methods for analysis of practical engineering problems. To develop the student's ability to formulate engineering problems in terms of mathematical model and to interpret the solution

Learning outcomes:

At the end of this module, students are expected to be able to:

1. Define Rectangular co-ordinate system, Spherical co-ordinate system and cylindrical co-ordinate system.
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 Rank of a Matrix, solve Simultaneous Equation by Matrix method,
4. Determine the consistency of linear equations;
5. Determine the characteristic equation and Eigen vectors and explain the properties of Eigen values.
6. Define Scalar point functions, vector point function, and the operator Del.
7. Interpret divergence and curl of a function.
8. Integrate a vector point function
9. Explain Green's Theorem and Stoke's Theorem
10. Explain Del applied functions in orthogonal curvilinear coordinates and cylindrical coordinates.

11. Use Multiple Integrals to determine the volume of solids, area of curved surface, centre of Gravity and Moment of inertia.
12. Solve Linear Differential Equations of higher order and simultaneous linear differential equations with constant coefficients
13. Apply the concept of LDE in simple Harmonic motion and simple pendulum

Learning and teaching approach used:

- Lectures : 4 hours/week
- Tutorial : 1 hr/week

Assessment

Continuous Assessment - 30 marks (30%)

1. Assignment - 10marks.
2. Mid Term Test - 10marks
3. Class Test - 10marks

Semester End Examination- 70marks (70%)

1. Written examination (3 hours) – 70 marks

Pre-requisite – Engineering Mathematics-I

Subject matter:

1. **Coordinate Geometry of Three dimensions:** Rectangular coordinate system- Introduction, Cylindrical and spherical coordinate system. Distance and angle. The plane, the Right line, intersection of line and a place, shortest distance between two lines, Intersection of two or more planes. The sphere, Tangent plane, Intersection sphere and a plane, radical plane, cones, cylinder, conicoids (using vector methods).
2. **Matrices:** Introduction. Definitions, special matrices, matrix algebra (addition, subtraction and multiplication). Related matrices, matrix inverse, solution of simultaneous equations Rank of a matrix, Elementary transformations of a matrix, Elementary matrices, Normal form of a matrix. Linear dependence of vectors, consistency of a system of linear equations. Linear transformations, orthogonal transformations characteristic equation. Eigen vectors, properties of eigen values. Caley-Hamilton theorem Reduction to diagonal form. Reduction of a quadratic form to canonical form. Complex matrices. Conjugate of a matrix, Hermitian matrix, skew Hermitian matrix: unitary matrix.
3. **Vector Calculus:** Differentiation of Vectors , curves in space, velocity and acceleration, Relation of Velocity and acceleration. Scalar and vector point functions-vector operator "del". Del-application to scalar point functions. Gradient. Del-application to vector point functions. Divergence and curl. Physical interpretation of divergence F and curl F. Del applied twice to point functions. Del applied to product of point functions. Integration of vectors line integral-circulation-wirk. Surface integral-flux Greens theorem in plane. Stoke's theorem. Volume integral. Divergence theorem. In rotational and solenoidal fields. "Greens theorem" Gauss theorem. Orthogonal curvilinear coordinates. Del applied to functions in orthogonal curvilinear coordinates cylindrical coordinates. Spherical and polar coordinates.
4. **Multiple Integrals:** Double integral, change of order of integration Double integrals in polar coordinates. Areas endosed by plane curves. Triple integrals. Volumes of solids. Change of variables. Area of a curved surface. Calculation of mass. Center of gravity. Center of pressure, moment of Inertia.
5. **Linear differential equation of higher order and its applications:** Definitions: Complete solution: Operator, Rules for finding complementary functions, Inverse operator. Rules for finding particular Integral, working procedure, method of variation of parameters cauchy's

and legendres linear equations. Simultaneous linear equations with constant coefficients. Applications:-Introduction, Simple Hormonic motion Oscillation of a spring. Simple pendulum.

Reading list:

1. Erwin Kreyszig (2002), "Advanced Engineering Mathematics", 8th edition, John Wiley & Sons (Asia) Pvt Ltd, Singapore.
2. Dr. B.S.Grewal (2001), "Higher Engineering Mathematics", 36th edition, Khanna Publishers, New Delhi.
3. H.K.Dass (2005), "Advanced Engineering Mathematics", 14th edition, S.Chand & Company Ltd, New Delhi.
4. R.K.Jain and S.R.K.Iyengar (2003), "Advanced Engineering Mathematics", 2nd edition, Narosa Publishing house, New Delhi.
5. I.B.Prasad (1982), "Practical Mathematics Vol I and Vol II", 6th edition, Khanna Publishers, New Delhi.
6. S.Balachandra Rao and H.R.Anuradha (1996), "Differential Equations with Application and Programmes", 1st edition, Universities Press (India) Ltd, Hyderabad.
7. A.R.Vasishtha (2002), "Matrices", 32nd edition, Krishna Prakashan Media(P)Ltd, Meerut.

Date: June 2011

Name of the Module : Building Drawing
Module Code : BPD201
Semester : II
Credit Value : 12
Module Leader : Mr. Ugyen Tenzey
Module Tutor : Mr. Ugyen Tenzey & Mr. Tshering Topgyel

General objectives:

To introduce and able to draw the components of building and facilitate the students to develop building drawings using AutoCAD.

Learning outcomes:

4. Upon successful completion of this course the student will be able to
   a. Draw various components of building – Masonry, Doors and Windows, Roofs and Staircases.
   b. Incorporate the traditional architectural elements of Bhutan in buildings
   c. Draw the building drawings with AutoCAD

Learning and teaching approach:

The concepts of drawings will be introduced through lectures and the drawings will be drawn by students during drawing classes. The students will be encouraged to draw free hand sketches of building components and the available time for learning is as below:

Lecture : 2 hrs/week

Practical : 3 hrs/week

Assessment:

Continuous assessment – 50 marks (50%)

1. Mid term Exam – 15 marks
2. Assignment – 10 marks
3. Tests – 5 mark
4. Project (mini) – 20 Marks

Semester End Examination – 50 marks (50%)

Written examination (4 hrs) – 50 marks

Pre-requisite: CE 101 – Engineering Graphics

Subject matter:

1. **Masonry:** Different type of brick bonds and stone masonry.
2. **Traditional Architecture:** History of Bhutanese architecture, elements of Bhutanese architecture (Chimthog/Roof and Thogcha/Truss, Rabsel/Baywindow, Payab and Mago/Window and Door, Kachen, Jamtho and Zhu/Columns and Brackets, Traditional Railings, and Cornices for different floor levels).
3. **Door and Windows:** Identify the components and draw the details of: Doors and Windows (Both conventional and traditional Bhutanese architecture).
4. **Staircase:** Draw the details of a traditional stair case: Dog legged type, and Open well type.
5. **Roof Truss:** Draw line sketches of the following roof trusses: King post, Queen post, Howe, Pratt, North light, Fink, Identify and draw various components of a King post roof truss, Draw the details of a traditional Bhutanese timber roof truss, Draw the details of a steel tubular roof truss with connection details.
6. **Plumbing and Assessories:** Identify the various components of septic tank and soak pit, Draw plan and section of a septic tank, Draw plan and section of a soak pit connected to the above septic tank, Sketch inspection chamber, gully trap, floor trap, p-trap, q- trap, s-trap and w.c (Squatting and English type) and soil pipe connections.
7. **Building Drawing:** Building bye-laws, types of buildings, Principles of building planning. Principles of building lighting. Draw Plan, sectional elevation, elevations and foundation details for the following:
   - Single storied (Bunglow) building incorporating traditional Bhutanese architecture.
   - Two storied (Duplex) building incorporating traditional Bhutanese architecture.
8. **Project:** Planning and Drawing of three storied traditional building with AutoCAD to a suitable scale, the plan, elevations sections and other details incorporating traditional Bhutanese architecture. Special consideration for space utilization, circulation, parking and aesthetical planning.

Reading list:

1. Bhatt, N.D., (2006). *Elementary Engineering Drawing* (16th ed.), Delhi: Charotar Publications.
2. Bhatt, N.D. and Panchal, V.M., (2002). *Engineering Drawing- Plain and solid Geometry* (17th ed.). Delhi: Charotar Publications.
3. Gopalakrishna, K.R., *Engineering Drawing and Graphics* (4th ed.). New Delhi: New Age International
4. Sikka, V.B., (2004). *A Course in Civil Engineering Drawing*". New Delhi
5. Thannikachalam V.and Natarajan K.V., (1986). *Civil Engineering Drawing Manual*". (7th ed.). New Delhi: S. Chand & Company (Pvt.) Ltd.

6. Verma, V.P, (2006), *Civil Engineering Drawing and House Planning*, New Delhi: Khanna Publishers.
7. Swamy, N. K. and Kameswara, R.A., (2007). *Building Planning and Drawing* (16th ed.). Delhi: Charotar Publishing House.
8. SP:7(1)-1983. *National Building Code of India 2005*. New Delhi: Bureau of Indian Standards.
9. DUDH, (2002). *Bhutan Building Rules 2002*. Thimphu: DUDH, MoWHS.

Date: June 2011

Name of the Module	**:**	Academic Skills
Module Code	**:**	ACS101
Semester	**:**	II
Credit Value	**:**	12
Module Leader	**:**	Ms. Pema Choezom
Module Tutor	**:**	Ms. Pema Choezom

General objectives or aims of the module:

The aim of this module is to enhance your basic English language competencies and equip you with the academic skills necessary for efficient study at university level.

Learning outcomes: On completion of the module the students should be able to:

Use your reading and critical thinking skills efficiently with textbooks, books, journal articles, reports and online sources.

- Locate and select sources by evaluating the credibility of an author, a publisher or a website; skim and scan; read for detail; distinguish between fact and opinion; understand the relationships between ideas in a text
- Collect and synthesise information using note-taking, summarizing and paraphrasing.

Use their critical writing skills effectively in informative and persuasive writing.

- Follow the writing process: planning, organizing ideas, sturcturing, synthesising, editing and proof reading.
- Combine information from sources with their thinking using their own words, including direct quotes only where appropriate.
- Acknowledge sources in the text and in the reference list, using internationally accepted conventions for references and documentation.
- Organize information according to the purpose of writing and the text type to be used.

Use their listening and critical thinking skills effectively in lectures and tutorials.

- Take notes
- Organize their notes using point form and headings as appropriate.

Use their speaking and critical thinking skills effectively in discussions, presentations and debates.

- Prounounce words clearly using the International Phonetic Alphabet (IPA) symbols and the stress marker guides found in the Oxford Advanced Learner's Dictionary.

Learning and teaching approach used
Tutors will employ an interactive, student-centered approach, integrating language and critical thinking skills using the following strategies.

- Demonstrations/ Modelling
- Practical exercises and activities/ Task based learning
- Individual, pair and group work)e.g. Discissions, problem-solving activities, preer feedback, debates, role-plays and simulations)
- Process learning (e.g. Portfoilo)
- Critical thinking
- Presentations
- Diagnosis, feedback and remediation

The time allocated for learning is given below.

- Lectures : 3 hours per week
- Tutorial : 1 hour per week
- Self study : 4 hours per week

Assessment:
Continuous assessment based on:
A **Portfolio** of work done in class and as homework including:

- At least 5 of the 6 portfolio tasks set out in the materials pack
- Grammar exercises (to be specified by class tutor)
- A minimum of four additional portfoli tasks, to be specified by class tutor
- A set of notes for class notes for this module (and notes from other listening situations if required by class tutor teacher specifies). **25%**

Two Class Tests (one mid-semester, one end-semester) 30%

Summative Assessment based on:

- **An oral presentation 15%**
- **A researched assignment (essay) 30%**

TOTAL: 100%

Important note on assessment: A student must complete all four components of the assessment and get and aggregate of 50% or above in order to pass. If a student does not complete all four components they fail the module.

Subject matter of the module:
Reading

- Locating, evaluating and selecting information
- Identifying text features and text organization
- Reading techniques (e.g. skimming and scanning, speed reading, SQ3R)
- Reading of text and making meaning
- Interpreting graphics
- Reading for detail
- Critical reading (e.g. identifying point of view and bias)
- Note taking, diagramming and mind-mapping

Writing

- Understanding assignment topics
- Understanding text types (informative writing and persuasive writing)
- Writing process (planning, researching, drafting, editing and proof reading)
- Summarizing and documentation (ethics of academic writing, presentation of written assignment, citation and quotations, reference list)
- Using reference texts effectively (e.g. dictionary, thesaurus and grammar books)
- Common errors (subject verb agreement, use of articles, use of tenses, use of active and passive voice, punctuation

Listening

- Following instructions
- Understanding lecture structure
- Using clues from gesture, body language and discourse markers
- Participating in discussions
- Critical listening
- Note taking and orgaizning notes

Speaking

- Fluency and accuracy
- Pronouncing words using IPA and stress markers in the OALD
- Pronunciation, stress and intonation in connected speech
- Using appropriate gestures, body language and discourse markers
- Asking and responding to questions
- Discussion
- Debate
- Presentation

Resources required: Computers, OHP and transparencies, tape-recorders or CD players, cassettes, whiteboard markers, whiteboard, speakers and headphones.

Required texts:
Oxford Advanced Learner's Dictionary, 8th Edition (Class set)

Recommended texts:
Academic Skills Student Pack (Sherubtse College), Rachael Davey 2010

Reading list:

** References marked with an **asterisk** in **bold** are the most immediately useful and are highly recommended.*

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*Anderson, K., Macclean, J. & Lynch, T. (2004). *Study Speaking: A Course in Spoken English for Academic Purposes*. Cambridge: Cambridge University Press.
*Bailey, S. (2010). *Academic Writing: A Handbook for International Students* (2nd Edition). Routledge.
Barnet, S., & Bedau, H. (2007). *Critical thinking, reading, and writing: A brief guide to argument* (6th ed.).
Bedford/St. Martin's.
*Bowler, B. Cunningham, S., Moor, P. & Parminter, S. (2004). *New headway pronunciation course upper*
intermediate (Students' book and audio CD). Oxford: Oxford University Press.
*Brick, J. (2006). *Academic Culture: A student's guide to studying at university.* Sydney: Macquarie University.
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*Cottrell, S. (2003). *The study skills handbook (2nd edition).* New York: Palgrave Macmillan.
* Davey, R. (2010) Academic Skills Student Materials, Sherubtse College(Electronic Version Available).
* Davey, R. (2010) Academic Skills Teacher Materials, Sherubtse College(Electronic Version Available).
* Eastwood, J.(2005) *The Oxford Guide to English Grammar*. Oxford: Oxford University Press.
*Gillet, A. UEFAP (Using English for academic purposes). www.uefap.com
*Gillet, A. , Hammond, A., Martala, M.(2009) *Inside track Successful Academic Writing.* London: Pearson Education.
*Guidelines for Teaching Academic Skills, RUB & Rita Skuja-Steele, 2010 (Electronic Version Available)
*Hancock, M., & Donna, S. (2007). *English pronunciation in use: Intermediate book with answers, audio CDs and CD-ROM (English pronunciation in use English pronunciation in use).* (Paperback). Cambridge : Cambridge University Press.
Infosys. (n.d.). *Effective pronunciation skills: Course book.* Mysore, India: Author.
Infosys. (n.d.). *Grammar for success: Course book.* Mysore, India: Author.
*Maimon. E.P., Peritz, J. H. & Rubens, M. (2005). *A writer's resource: A handbook for writing and research*. (Can. Ed.). McGraw- Hill Ryerson.
*Messenger, W.E., de Bruyn, J., Brown, J & Montagnes, R. (2004). *The Canadian Writer's Handboo*k, Oxford University Press.
*Open Learn: The Open University (2010) *Skills* http://openlearn.open.ac.uk/course/category.php?id=12
*Oshima, A. & Hogue, A. (2006). *Writing Academic English (4th ed).* Longman
*OWL at Purdue (2010). APA style. http://owl.english.purdue.edu/owl
* OWL at Purdue (2010) *Online Writing Lab.* http://owl.english.purdue.edu/owl/resource
*Philpot, S. & Curnick, L. (2007). *New Headway Academic Skills: Student's Book Level 3: Reading, Writing, and Study Skills*. Oxford University Press.
Phillips, T (2004).Skills in English: Listening Level 3. Book and CD. Reading: Garnet
*Powell, M. & Marks, J. (1996). *Presenting in English. Book and Cassette*. London. Language Teaching Publications.
*Ramsey-Fowler, H. & Aaron, J.E. (2009). *The Little Brown Handbook*. Longman.
*Rogerson, P. & Gilbert, J. (1990). Speaking Clearly: Students' Book, Teacher's Book and Casette. Cambridge: Cambridge University Press.
*Swan, M. (2005) *Practical English Usage*, Oxford: Oxford University Press
Thomson, A.J. & Martinet, A.V. 1990, *Practical English Grammar with exercises* Prentice Hall, UK.
*Turtor, N.D. & Heaton, J.B. (1987). *Longman dictionary of common errors.* Delhi: Pearson Education.
*University of New South Wales (2010) *Online Academic Skills Resources* http://www.lc.unsw.edu.au/olib.html
*University of Southampton (2009) *Academic Skills.* http://www.studyskills.soton.ac.uk

Date: June 2011

Name of the Module	**:**	Object Oriented Programming (C++)
Module Code	**:**	CPL102
Semester	**:**	II
Credit Value	**:**	12
Module Leader	**:**	Mr. Tshering
Module Tutor	**:**	Tsheten Dorji and Yeshi Wangchuk

General objectives:
The objective of the module is to introduce students to object-oriented programming and write well-structured object-oriented programs.

Learning outcomes:
At the end of this module, students are expected to be able to:
1. Differentiate between Procedural Programming and Object Oriented Programming.
2. Code, run and debug programs.
3. Use OOP languages
4. Apply OOP concept in solving science and engineering problems.

Learning and teaching approach used:

Lectures	:	2 hours per week
Tutorial	:	1 hour per week
Laboratory practical	:	2 hours per week

Assessment:
Continuous assessment-25 marks
Practical assessment – 25 marks
Semester end examination – 50 marks

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%.

Subject matter:
1. **Principle of Object-Oriented Programming:** Software Evolution, The Traditional approach, Basic Concept of Object-Oriented Programming, Benefits of OOP, Object-Oriented Languages, object-oriented design concept.
2. **Programming Basics:** Basic Program Construction, Input/Output, Data Types, Processor Directives, Manipulators, Type Conversions, Arithmetic Operators & Library Function.
3. **The Class**:Basics of the class, constructors, destructors, memory allocation, operator overloading, friend operators.
4. **Classes & Objects:** Specifying a Class, Defining member Functions, Inline Functions, Private member Functions, Arrays within a Class, Memory Allocation for Objects, Objects as Function Arguments, Friendly Functions, Returning Objects, Const member functions & Pointer to Members
5. **Constructors & Destructors, Operator Overloading:** Constructors, Multiple Constructors in a Class, Copy Constructors & Copy Constructors, Destructors, Operator Overloadings & Type Conversions.
6. **Inheritance:: Extending Classes:** Derived Class & Base Class, Derived Class Constructors, Overriding Member Functions, Class Hierarchies, Private & Public Inheritance, Multiple Inheritance, Containership: Classes within Classes
7. **Virtual Functions & Polymorphism:** Virtual Functions, Friend Functions, Static Functions, this Pointer.
8. **Files & Streams:** Stream (Classes & Header Files), String I/O, Character I/O, Object I/O.

9. **Templates & Exception Handling:** Templates (Class, Functions, Member Function Templates), Exception Handling.

List of Practicals:

1. Program debugging.
2. Class implementation.
3. Inheritance implementation.
4. Polymorphism implementation.
5. Template implementation.
6. Search algorithm.
7. Sort algorithm.
8. File operation.

Reading list

1. E. Balagurusamy(2008), *Object Oriented Programming with C++,* Tata McGraw Hill
2. Ravindran, D (2005), *Programming with C++, Tata McGraw Hill*, New Delhi.
3. Pinson, J (1998), *Introduction to Object Oriented Programming with C++*, Richard Wiener Lewis Pub Company.
4. Musser, D.R., Stepanov, Alexander, Saini and Atul (2002), *C++ Programming with the Standard Template Library*, Addison Wesley Publishing Co
5. Cohoon (2002), *C++ Program Design*, Tata McGraw Hill, New Delhi.

Date: June 2011

Name of the Module	**:**	Engineering Mechanics
Module Code	**:**	TSM101
Semester	**:**	II
Credit Value	**:**	12
Tutors Leader	**:**	Mr. Om Kafley
Tutors Tutor	**:**	Mr. Om Kafley

General objectives or aims of the module:

This module will introduce the basic concepts of static and dynamics of solids under the actions, reactions of forces and moments which are essential for any branch of engineering students at graduate level. This will develop the student's abilities to solve simple static and dynamic systems and structures using the knowledge and understanding and analytical tools provided through this module. To consolidate the above basic concepts learned through lectures (theory) by experiments. To develop the student's abilities to measure and conduct experiments to verify the principles and solve simple static and dynamic systems through experiments.

Learning outcomes:

At the end of this module, students are expected to be able to:

1. Determine resultant of a system of forces including the moments by analytical as well as graphical methods.
2. Analyse the equilibrium conditions of a body/structure under the actions of system of forces (external as well as internal) including the frictional forces using equations of equilibrium and free body diagrams.
3. Determine the properties like center 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 (linear motion, rotation and translation and their combination) using kinematics principles (Newton's laws of motion).
6. Determine the characteristics of projectile motion of a body.
7. Analyse the body/structure under motion (linear motion, rotation and translation and their combination) using kinetics principles (D'alemberts principle and work –energy equations).
8. Analyse the rigid and elastic body/structure under impact loads using principles of momentum and energy.
9. Analyse the body/structure using the principle of virtual wok.
10. Verify the various laws of forces and moments learned in theory through experiments.
11. Find the law of machine for various lifting machines available in the laboratory through experiments.
12. Use laboratory equipment, correctly and safely, to make measurements.

Learning and teaching approach used:

The concepts of the various principles are introduced through lectures with examples and their application to real time problems. This will be is followed by solving few typical problems. The students are encouraged to study by their own on various imaginary problems and practical problems to consolidate their concepts and understanding of the principles involved in the analysis of solids/structures under influence of system of forces or through tutorials/assignments. The concepts learned through lectures will be verified through the experiments during the laboratory classes to consolidate their concepts.

The time allocated for learning is given below.

- Lectures : 3 hours per week
- Tutorial : 1 hour per week
- Laboratory Practical : 2 hours per week

Assessment:

- **Theory – 75 marks**

  Continuous assessment - 25 marks

  1. Assignment – 5 marks
  2. Mid-term Test (closed book) - 10 marks
  3. Class test/ surprise test/ quizzes - 10 marks.

  Semester End Examination - 50 marks

  1. Written examination of 3 hours duration (Closed book) – 50 marks
- **Practical continuous assessment - 25 marks**
  1. Regular laboratory assessment – 15 marks as shown in annexure - I
  2. Practical examination/quiz/viva voce – 10 marks

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%.

Subject Matter:

1. **Fundamental concept:** Unit and dimension, fundamental law of mechanics, scalar and vector quantities

2. **Composition and Resolution of forces:** Composition of force, Resolution of force, Analytical method, and graphical method, Composition of forces by Resolution.
3. **Moments and couples:** Moment of force, Varignon's theorems, couple, and resultant of a force system, Type of levers.
4. **Equilibrium:** Equilibrium of a body, Equilibriant, type of forces on a body, FBD, Lami's theorem, Equilibrium of connected bodies, Equilibrium conditions, reaction, loading and support of beams.
5. **Friction:** Frictional force, laws of frictions, angle of friction angle of cone, angle of repose, Wedges, Rope friction, Nonconcurent force problem.
6. **Centre of gravity and moment of inertia:** Centre of gravity, Centre of gravity of a flat plate and solid, centriod, axis of symmetry, Center of gravity from first principal, centered of composite section, moment of inertia, Polar moment of inertia, Radius of gyration, Theorems of moment of inertia, moment of inertia from first principal, moment of inertia of standard section, moment of inertia of composite section.
7. **Principle of lifting Machines:** Law of machine, Mechanical advantage, pulleys, wheel and axle, screw jack, differential, screw jack, wrenches screw jack, wrench crab (single and double), worm and worm wheel, inclined plane.
8. **Linear motion and combined motion of rotation and translation:** General principle of dynamics, type of motion, Motion curve, motion with uniform velocity, acceleration with gravity, motion with varying acceleration, motion in a plane in any direction, relative distance, Newton's law of motion I, II, and III, D' Albert's principal, acceleration during circular motion, motion on level road, designed speed, skidding and overturning, angular motion, kinetic energy of rotating bodies, relation between angular motion and linear motion, motion of connected bodies.
9. **Projectiles:** Definition, motion of bodies projected horizontally, inclined projection on level ground, projection on inclined plane, inclined projection with point of projection.
10. **Work, power and energy:** Work, work done by a varying force, energy, power, work energy equation for translation and rotation, motion of connected bodies, work done by a spring.
11. **Impulse of momentum and impact of elastic bodies:** Linear impulse and momentum, force of a jet on vane, pile and pile hammer, conservation of momentum, impact of elastic bodies, coefficient of restitution, oblique impact, loss of kinetic energy, impulse of force, impulse of impulsive force
12. **Virtual Work:** Principle of Virtual Work, Application of the principal of virtual work.

List of Practicals:

1. Verification of triangle law.
2. Verification of polygon law.
3. Verification of Law of parallelogram.
4. Verification of Law of Friction for rolling friction and plane friction for different surfaces.
5. Determination of Law of Machine for Worm and Worm wheel, Single Purchase Crab, Differential wheel and axle, pulleys, screw jack.
6. Verify Principle of moment.
7. Determination of moment of inertia of flywheel

Reading list:

1. S.S. Bhavikatti & K.G. Rajashekarappa (2006), "Engineering Mechanics", New Age International Publishers, New Delhi.
2. K. L. Kumar (2009), "Engineering Mechanics", TMH, New Delhi.

3. Shigley, (1976) “Applied Mechanics of Materials”, McGraw Hill Publications, International Student Edition.
4. R.S. Khurmi (1967), “Text Book of Engineering Mechanics”, S.Chand & Co, New Delhi.
5. N.C.Sinha and S.K.Sen Gupta (1987), “Elements of Structural Mechanics”, S.Chand & Co., New Delhi.
6. M.M.Malhotra et. Al.(2005), “A Text Book in applied Mechanics”, New Age International Publishers, New Delhi.
7. S.Timoshenko & D.H.Young (2009), “Engineering Mechanics”, McGraw Hill Publications, International Edition.
8. Irving H. Shames (2009), “Engineering Mechanics–Statics & Dynamics”, Prentice Hall India, New Delhi.
9. R.C. Hibbeler, (2010) “Engineering Mechanics-Statics”, Pearson Education Asia Pvt. Ltd.
10. D.R.Malhotra & H.C.Gupta (2000), “Applied Mechanics & Strength of Materials”, Satyaprakashan Publishers, New Delhi.
11. S.B. Junarkar (1987), “Elements of Applied Mechanics”, Charotar Publications, Anand.
12. S Ramamrutham (1997), “A text Book of Applied Mechanics”, Dhanpat Rai Publications, New Delhi.

Date: June 2011.

Semester III

Name of the Module	**:**	Engineering Mathematics-III
Module Code	**:**	MAT201
Semester	**:**	III
Credit Value	**:**	12
Module Leader	**:**	Mr. S.T. Venkatesan
Module Tutor	**:**	S.T. Venkatesan and Jayachandran V

General objectives or aims of the module:

To give students a broad and deep knowledge of the mathematics of Complex Analysis which forms the background for much theoretical work in engineering.To introduce the structure of Laplace Transform, Fourier Series, Linear Partial Differential Equations and how they relate to engineering situations.

Learning outcomes:

Upon the successful completion of this module, student will be able to;

1. Demonstrate knowledge and understanding of the concepts of analytic functions
2. Find the conditions under which differentiation of functions of a complex variable is possible (Cauchy-Riemann conditions)
3. Relate these conditions to the Laplace equation and apply it to basic problems of flow
4. Expand complex functions as Laurent series about singular points and find residues of these functions to perform straightforward tasks of complex integration.
5. Use of complex integration for solving real integrals
6. 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.
7. Solve Partial Differential Equations critically and efficiently using the appropriate methods.

8. Find the solution of Heat, Wave, Laplace equations of Polar and Cartesian Co-ordinates Systems.
9. Use the basic working knowledge of Mathematical methods in Laplace Transform and Partial Differential Equations with the facility to apply the methods in engineering situations.
10. Apply the mathematical methods of Fourier Series to solve a wide range of problems in both Science and Engineering

Learning and teaching approach used:

- Lectures : 4 hrs/week
- Tutorial : 1 hr/week

Assessment:

Continuous Assessment - 30 marks (30%)

1. Assignment - 10marks
2. Mid Term Test- 10marks
3. Class Test - 10marks

Semester End Examination - 70marks (70%)

Written examination (3 hrs) – 70 marks

Pre-requisite: Engineering Mathematics – I & II

Subject matter

1. **Partial Differential Equations and Boundary value Problems:** Introduction: Formation of Partial Differential Equations. Solution of Standard Types Partial Differential Equations. Equations solvable by Direct Integration. Linear Equations of First Order. Non-linear Equations of First Order. Char pit's Method. Homogeneous Linear Equations with constant coefficients. Rules of finding particular integral (P.I). Working procedure to solve Homogeneous Lnear Equations of any order. Non-homogeneous Linear Equations. Non-linear Equations of second order-mange's method. Applications of Partial Differential Equations: Classification of linear second order PDE, Variable separable method; solution of Heat, Wave, Laplace equations – Polar and Cartesian Co-ordinate systems
2. **Laplace Transformations:** Introduction: Definition, Transforms of Elementary Functions. Properties of Laplace Transforms. Existence conditions. Inverse transforms. Note on partial fraction. Transforms of Derivatives. Transforms of Integrals. Multiplication by t n. Division by 't'. Convolution Theorem. Applications of Laplace Tranforms to Differential Equations. Simultaneous linear equations with constant coefficients. Unit Step Functions, Unit Impulse Functions. Periodic Functions. Special Functions.
3. **Complex Variables:** Introduction: Function of a complex variable continuity of a complex variable function. Derivative of f(z). Cauchy-Riemann equations. Analytic functions. Harmonic Functions orthogonal system- orthogonal system. Geometrical representation of f(z). Applications to flow and two dimensional potential problems. Conformal transformation. Some standard transformation. Schwartz-christoffel transformations. Integration of complex function. Cauchy's theorem (simple problems) Cauchy's integral formula. Series of complex functions. Taylor's series and Laurent's series, singular points-residues. Calculus of Residues theorem, Contour integration-Evaluation of real definite integrals.
4. **Fourier Series:** Introduction: Euler's Formulae. Fourier expansion conditions - Dirichlet. Function having a point of Discontinuity, Change of Interval, Odd and Even Functions. Half range series Expansion. Typical waveforms Parsevals Identity, Complex or Exponential form

of Fourier Series, Practical Harmonic Analysis.

Reading list:

1. Erwin Kreyszig (2002), "Advanced Engineering Mathematics", 8th edition, John Wiley & Sons (Asia) Pvt Ltd, Singapore.
2. Dr. B.S.Grewal (2001), "Higher Engineering Mathematics", 36th edition, Khanna Publishers, New Delhi.
3. H.K.Dass (2005), "Advanced Engineering Mathematics", 14th edition, S.Chand & Company Ltd, New Delhi.
4. R.K.Jain and S.R.K.Iyengar (2003), "Advanced Engineering Mathematics", 2nd edition, Narosa Publishing house, New Delhi.
5. I.B.Prasad (1982), "Practical Mathematics Vol I and Vol II", 6th edition, Khanna Publishers, New Delhi.
6. S.Balachandra Rao and H.R.Anuradha (1996), "Differential Equations with Application and Programmes", 1st edition, Universities Press (India) Ltd, Hyderabad.
7. Murray R. Spiegel (1965), "Theory and Problems of Laplace Transorms", Schaum's Outline Series, McGraw-Hill Book Company, Singapore.

Date: June 2011

Name of the Module : Fluid Mechanics
Module Code : FMH201
Semester : III
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:

The course introduces fundamentals characteristics of fluids and their behavior in static and dynamic systems.

Learning outcomes:

Upon successful completion of this course the students will be able to:

a. Apply conservation principles (mass, momentum, energy, Bernoulli) to analyse a variety of problems in fluid statics and dynamics.
b. Calculate the forces that act on submerged planes and curves.
c. Identify flow types.
d. Apply the laws of fluid mechanics to turbulent and laminar flow through pipes and ducts in order to predict relevant pressures, velocities and forces.
e. Draw simple hydraulic and energy gradient lines.

Learning and teaching approach used:

Lectures are used as the basic method of introducing new concepts and material. These are reinforced by tutorials to resolve areas of uncertainty. Problems sheets give essential practice in applying the new knowledge to analytical and design examples.

Laboratory classes provide experience of simple fluid flow conditions.

Directed reading & assignments are used to help students to monitor their own progress in the module.

Lectures : 3 hrs/ week

Tutorial : 1 hr/week

Laboratory practical: 2 hrs /week

Assessment:

Theory

Continuous assessment - 25 marks (25%)

1. Assignment – 5 marks.
2. Mid term Test- 10 marks.
3. Class test- 10 marks.

Semester End Examination - 50 marks (50%)

Written examination (3 hours) – 50 marks.

Practicals

Continuous assessment - 25 marks (25%)

1. Regular assessment of the experiments – 15 marks.
2. Practical examination/quiz/viva voce – 10 marks

Pre-requisite: Engineering Mechanics, Engineering Mathematics.

Subject matter:

1. **Introduction to fluid mechanics:** Development of fluid mechanics, Definition of fluid, Properties of fluid-Compressibility, Mass density, Specific weight, Specific volume, Specific gravity, Viscosity, Kinematic viscosity, Bulk modulus, Gas law, Vapour pressure, Surface tension, Capillarity.
2. **Pressure Measurement**: Pressure, Pascal's law, Pressure variation with depth of liquid, Absolute gauge and vacuum pressure, Mercury barometer, Aneroid barometer, Measurement of gauge pressure, Manometers, open type and differential manometers, inverted differential manometers, micro manometers.
3. **Hydrostatics**: Total pressure on a horizontally immersed surface, Total pressure on a vertically immersed surface, Total pressure on an inclined immersed surface, centre of pressure of a vertically immersed surface, pressure on curved surface, pressure diagram, pressure due to one kind of liquid on one side, pressure due to one kind of liquid over another on one side, application of hydrostatics, water pressure on rectangular masonry dams, water pressure on trapezoidal dams.
4. **Fluid kinematics**: Hydro kinematics- Introduction, rate of discharge, Equation of continuity of liquid flow, Motion of fluid particles- Lagrangian and Eulerian methods, Types of flow lines- path lines, Stream lines, steak lines or filament lines, potential lines or equipotential lines, flow net, uses of flow net, Type of flow in a pipe- Uniform and Non-Uniform, Stream line & 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.
5. **Fluid Dynamics**: Introduction- Energy of liquid in motion, Total energy or total head of liquid particle in motion, Bernoulli's equation, Euler's equations of motion, limitations of Bernoulli's equation, Impulse-Momentum equation, Momentum correction factor, Application and comparison of momentum equation and energy equation.

6. **Flow Measurement:** Venturimeter, Orificemeter, Pitot tube, Flow through Orificemeter, types of Orificemeter, jet of water, Venacontracter, Hydrolic coefficients, 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, flow through mouth pieces-types, discharge – external mouthpiece, discharge –internal mouthpiece-running free and running full, flow through nozzle, Bend meter, flow over notches- types, discharge over rectangular notch and triangular notch, advantage of triangular notch over rectangular notch, Discharge over trapezoidal notch, 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.
7. **Flow through pipes**: Introduction, Reynolds's experiment on flow through pipes, Darcy-Weisbach equation, wetted parameter, area of flow, hydraulic radius, empirical formula-Chezy's formula, Manning's formula, Hazen-William's formula, Gangvillet-Kutter's formula, Minor losses, 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.
8. **Laminar Flow in Pipes:** Relationships between shear stress and pressure-gradient, Hagen-Poiseuille law, Laminar flow thorough inclined pipes, Flow through porous media, Concentric cylinder, Measurement of viscosity.
9. **Turbulent Flow in Pipes**: General expression for shear stresses, Boundary layer in pipes, (laminar and turbulent), Hydrodynamically smooth and rough pipes, Velocity distribution-equation for smooth and rough pipes.

Practicals:

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 f Hele-Shaw apparatus
6. To find losses in a piping systems and loss factors in a piping system

Reading List:

1. Modi, P.N. and Seth, S.M., (1973). *Hydraulics and Fluid Mechanics* (14th ed.). Delhi: Standard Book House.
2. Jain, A.K., (1998). *A text book of Fluid Mechanics*, (9th ed.), Delhi: Khanna publisher.
3. Khurmi R S, (1988). *A textbook on Hydraulics*, (16th ed.), Delhi: S Chand & Company.
4. Lal Jagdish, (2002). *Fluid Mechanics & Hydraulics*, (9th ed.), Delhi: Metropolitan Book Co.
5. Giles, Ranald V., (2006*). Schaum's outline of theory and problems of fluid mechanics and hydraulics,* (2nd ed.), Delhi: Tata McGraw Hill.
6. Gupta, V , P, Sing Alam and Gupta Manish, (2004). *Fluid mechanics, fluid machines and hydraulics*, (2nd ed.), Delhi: CBS.
7. Asawa G.L., (1987). *Experimental Fluid Mechanics, vol. 1*, (3rd ed.), Roorkee: Nem Chand & Bros.
8. Garde, R.J and Gaoker Miraj, (1983). *Engineering Fluid Mechanics*, (2nd ed.), Delhi: Nem Chand & Sons.

9. Rajput, R.K, (2002). *Fluid Mechanics and Hydraulic Machines*, (2nd ed.), Delhi: S Chand & company.
10. Rajput RK, (2002), *Fluid Mechanics& Hydraulic Machines*, (2nd ed.), Delhi: S Chand &company.
11. K.Subramanya, (2001). *Theory and application of fluid Mechanics*, (2nd ed.), Delhi: Tata-Mc Graw Hill.
12. Garde, R.J and Gaoker Miraj, (1983). *Engineering Fluid Mechanics (including Hydraulic Machine)*, (2nd ed.), Roorkee, Nem Chand & Bros.
13. Kumar K L, (1976). *Engineering Fluid Mechanics*, (1st ed.), Delhi: Eurasia Publishing House.
14. Gupta Vijay & Gupta Santosh K, (2000). *Fluid Mechanics & its application*, (3rd ed.), Delhi: New age International.
15. Bansal, R. K., (2005). *A textbook of fluid mechanics and hydraulics machines*, (3rd ed.), Delhi: Laxmi Publications.
16. Streeter,V.L., (1983). *Fluid Mechanics*, (1st ed.), Delhi: Tata-McGraw Hill Company.
17. Besavilla, Venancio I., (1986). *Fluid mechanics / Hydraulics,* (2nd ed.), Delhi: VB Publisher.
18. Arora, K.R., (1980). *Fluid mechanics hydraulics and hydraulic machines,*(2nd ed.), Delhi: Standard Publishers Distributors.
19. Lal, Jagdish., (2002). *Fluid mechanics and hydraulics / Computer applications,*(2nd ed.), Delhi: Metropolitan Book.
20. Govida Rao N S., (1976). *Mechanics of fluid*, (2nd ed.), Delhi: Orient Longman.
21. Narayana Pillai and C R Ramakrishna, (1999). *Principles of Fluid Mechanics and Fluid Machines*, (2nd ed.), Delhi: Universities press.
22. Vennard, J.K., (2001). *Elementary Fluid Mechanics*, (3rd ed.), Delhi: John Wiley.
23. Likhi S K, (2001), *Hydraulics Lab Manual*, (NA),

Date: June, 2011

Name of the Module : Principle of Surveying – I
Module Code : SUR201
Semester : III
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Mr. Tshering Tobgyel

General objectives or aims of the module:
To introduce principles of surveying and applications of linear and angular measuring instruments.

Learning outcomes:
The students should know the following upon successful completion of the module:

a. To demonstrate the basic surveying skills
b. To demonstrate various surveying instruments.
c. To perform different methods of surveying
d. To compute data required for surveying.
e. To integrate the knowledge and produce topographical map.

Learning and teaching approach used

Lectures will be used as the basic method of introducing concepts and this will be reinforced by tutorials to gain analytical skills. Practical classes are provided to give experience on the use of various instruments. These skill be provided by the following means;

Lectures : 2 hrs/Wk

Tutorial : 1 hrs/Wk

Laboratory practical: 3hrs/Wk

Assessment

Continuous assessment – 50 marks (50%)

Theory – 25 marks (25%)

1. Mid term exam - 10 marks.
2. Assignment – 10 marks.
3. Case Study – 5 marks

Practical – 25 marks (25%)

1. Assignment - 20 marks
2. Test - 5 Marks

Semester End Examination – 50 marks (50%)

Written examination (3hrs) - 50 Marks

Pre- requisite: MA 201 – Engineering Mathematics – II and CE 101 Engineering Graphics.

Subject matter:

1. **Introduction:** Importance of surveying, classification of surveys, stages of survey operations, principle of surveying, conventional signs, surveying instruments, their care and adjustment.
2. **Measurement of Distances:** Principle of different methods and their accuracies, measurement by tape, sources of errors and precautions, corrections to tape measurements.
3. **Measurement of Angles and Directions:** Reference meridians, bearing and azimuths, magnetic declination and its variations, use and temporary adjustments of compass, theodolites, measurement of horizontal and vertical angles by theodolites.
4. **Traversing:** Principles of traversing by compass and theodolite, field work and checks, computation of coordinates by using Gale's traverse table, sources of errors, precision of traversing, checking and adjusting of traverses, omitted measurements.
5. **Measurement of Elevations:** Different methods of determining elevations-leveling, Trigonometric, Tachometry, definitions of terms, principle, temporary and permanent adjustments of levels, methods of booking and reduction of field notes, introduction to curvature and refraction corrections, reciprocal leveling, plotting of profiles, reciprocal observations, sources of errors and precision of leveling procedures.
6. **Plane Table Surveys:** Principles, advantages and disadvantages, plane table equipment, methods of plane table surveying, Resection-two and three point problems, field work in plane table surveying.
7. **Contouring:** Definition and characteristics of contours, use of contour maps, direct and indirect methods of contouring.

Laboratory Practical:

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 reduced levels of given points using levelling instruments by both height on instrument and rise and fall methods.
5. Establish a Benchmark by check levelling.
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.
11. Conduct contouring by direct and indirect method.

Reading List:

1. Agor. R, (2000), *Surveying vol. I* (3rd ed.), Delhi: Khanna publications.
2. Agor. R, (2000), *Surveying vol.II* (3rd ed.), Delhi: Khanna publications.
3. Arora R, (2000), *Surveying vol. I*, (3rd ed.), Delhi: Khanna publications.
4. Arora R, (2000), *Surveying vol. II*, (3rd ed.), Delhi: Khanna publications.
5. Duggal, S. K. (2007). Surveying –I, (2nd ed.), Delhi: Tata Mcgraw Hill.
6. Duggal, S. K. (2007). Surveying –II, (2nd ed.), Delhi: Tata Mcgraw Hill.
7. Chandra,A.M. (2005). Surveying –I, (2nd ed.), Delhi: New Age International.
8. B.C.Pumia. (2000). Surveying -I (3rd ed.) , Delhi: Laxmi Publications.
9. B.C.Pumia. (2000). Surveying -II (3rd ed.) , Delhi: Laxmi Publications
10. Rangwala, S. C., (2005*). Surveying and levelling*, (2nd ed.), Delhi: Charotar Publishing House.
11. Husain, S.K. (1985). *Textbook of Surveying*, (1st ed.), Delhi: Oxford & IBH Publishing Co.
12. Arthur. B. and Stanley R. (2006), Surveying, (2nd ed.), Delhi: Prentice-Hall

Date: June 2011

Name of the Module : Strength of materials
Code of the Module : TSM201
Semester : III
Credit value : 12
Module leader : Mr. Sabaur Rahman
Module Tutor : Mr. Sabaur Rahman & Ms. Chimi Wangmo

General objective:

To introduce the concepts and fundamentals of behavior of structural materials when subjected to various loads.

Learning outcomes:

8. Upon successful completion of this course the student will be able to:
   a. Explain mechanical properties of engineering materials.
   b. Draw shear force and bending moment diagram with different loads and support conditions.

c. Compute bending stresses, shear stresses and shear centre.
d. Compute principal stresses, strains and direction of planes.
e. Design of shafts.
f. Compute forces in truss members by different methods.
g. Compute buckling load by Rankine and Euler's approach.
h. Compute slope and deflection of beams by double integration method, moment area method, conjugate beam method, Macaulay's method.
i. Design thin cylindrical and spherical shells.
j. Analyze fixed and continuous beam using Clapeyron's theorem.
k. Conduct relevant tests on materials and analysis the data.

Learning and teaching approach used:

Lectures introduce concepts and the basic behaviour of materials and structures under different loadings and loading conditions. Practical examples are used to clarify salient features and to illustrate the concepts. Tutorial sessions are conducted to develop problems solving skills and awareness of practical application of the subject matter. The relevant experiments will be conducted to consolidate the various concepts introduced in this module.

Lecture: 3 hrs./wk

Tutorial: 1 hr./wk

Practical: 2 hrs/wk

Assessment

Theory:

Continuous assessment - 25 marks (25%)

1. Assignments -10 marks.
2. Mid term test -10 marks.
3. Class test - 5 marks

Semester End Examination - 50 marks (50%)

Written examination (3 hrs. duration) – 50 marks

Practical:

Continuous assessment: 25 marks (25%)

1) Evaluation of regular practical works - 15 marks
2) Internal Practical examination/ viva-voce - 10 Marks

Pre-requisite: Engineering Mechanics.

Subject matter:

Theory

1. **Simple stresses and strain:** Elastic and plastic behaviour of engineering materials, mechanical properties, analysis of simple stresses and strains, elastic constants, thermal stresses, complimentary shear stresses and strains, strain energy.
2. **Bending moment and shear force:** 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.
3. **Bending stress and shearing stress:** Bending and shearing stresses in beams- symmetrical and unsymmetrical section, solid and thin walled sections.
4. **Torsion:** Torsion in solid and hollow shaft, design of shaft.

5. **Compound stresses:** Principles plane and principles stresses, Mohr's circle, principal strain.
6. **Combined stresses:** Beams subjected to bending and shear, shafts subjected to bending and torsion, short columns.
7. **Analysis of Truss:** Analysis of Truss by method of section, method of joints and graphical method.
8. **Slope and deflection of beams:** Slope and deflection of beams by double integration method, moment area method, conjugate beam method, Macaulay's method.
9. **Column and strut:** Buckling of struts, eccentrically and axially loaded columns, analysis of columns and strut using Rankine's and Euler's approach.
10. **Thin cylindrical and spherical shells:** Thin cylindrical and spherical shells and internal pressure, change in volume of cylindrical shells.
11. **Fixed and Continuous beams:** Clapeyron's Theorem of three moments, EI constant.

Practicals:

1. Introduction to testing equipment.
2. Uniaxial tension test (Mild steel and Timber).
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 List:

1. Bhavikatti, S. S. (2009). *Strength of materials*, (2nd ed.), Delhi: Vikas.
2. Ramamrutham, S. (2009). *Strength of materials,* (2nd ed.), Delhi: Dhanpat Rai
3. Prasad, I. B. (2006). *A text book of strength of materials*, (2nd ed.), Delhi: Khanna Publishers.
4. Negi, L.S. (2008). *Strength of materials*, (3rd ed.), Delhi: Tata McGraw Hill.
5. Timoshenko. S. (2004). *Strength of materials*, (2nd ed.), Delhi: CBS.
6. Nash. W. A. (2007). *Strength of materials, (2nd ed.),* Delhi: Tata McGraw Hill.
7. Sarkar, B.K. (2008). *Strength of materials, (3rd ed.),* Delhi: Tata McGraw Hill.
8. Sood. H. (2007). *Laboratory manual on testing of engineering materials, (1st ed.),* Delhi: New Age International.
9. Khurmi, R. S.(1988). *Strength of materials*, (2nd ed.), Delhi: S. Chand and Co.

Date: June 2011

Name of the Module : Building Materials and Construction
Code of the Module : BPD202
Semester : III
Credit Value : 12
Module Leader : Mr. Tshering Tobgyel
Module Tutor : Mr. Tshering Tobgyel and Mr. Ugyen Dorji

General Objective or Aim of the Module:

The aim of this module is to study the nature and charactistics of various building materials used in the building construction industry and its various applications, and methods of building construction.

Learning Outcomes:

Upon the successful completion of this module, the students will be able to:

1. Describe the types and properties of stones, bricks, timber, and their applications in the building industry.
2. Describe the characteristics of concrete ingredient materials and their influence on the properties of concrete.
3. Describe the types, production, and proportioning of concrete materials and the important characteristics of concrete.
4. Describe the types and properties of various metals like Ferrous (Iron and Steel) as well as Non Ferrous (Aluminum, Zinc, Bronze, Brass) metals and their applications in the building industry.
5. Describe the types and properties of plastics and their applications in the building industry.
6. Describe the types and properties of various glasses and their applications in the building industry.
7. Describe the quality control measures through destructive and non-destructive tests.
8. Describe the need for the building bye-laws and the local building bye-laws.
9. Describe the various types of foundations and their suitability, and selection criteria for a particular building.
10. Describe the various types of stone masonry and their suitability, and the construction methods including quality control measures (guidelines for supervision).
11. Describe the various types of brick masonry (brick bonds) and their suitability, and the construction methods including quality control measures (guidelines for supervision).
12. Describe the various types of walls including partition and cavity walls along with the design criteria.
13. Describe the various types of damp proofing materials and techniques.
14. Describe the various types of floors, their construction details, and selection criteria.
15. Describe the various types of roofs and roof coverings including the treatment for water proofing of roofs.
16. Describe the various types of doors and windows and their locations, sizes and materials.
17. Describe the various types of stairs and staircases and their locations, sizes and materials including fire escapes and also lifts and escalators.
18. Describe the methods of white/colour washing and paintings including distempering.
19. Describe the various methods of shuttering, scaffolding and centering.
20. Describe the various types expansion and construction joints and their construction.
21. Describe the methods of sound and fire proof constructions as per I.S.standards.
22. Conduct various tests on the construction materials in the laboratory to assess their suitability for construction.

Learning and Teaching Approach:

The properties, specifications and the uses of different construction materials are introduced through lectures with examples and their application to real time structures. These lectures will be supplemented by relevant visual aids and site visits. The students are encouraged to select and use the appropriate materials for the real time structures. The students will be familiarised with testing procedures to determine the various properties of the commonly used materials in construction during the laboratory classes. To get the physical feeling of the materials and structures, they are advised to visit as many as construction sites in the vicinity.

The time allocated for these activities is given below.

Lectures : 3 hours/week

Tutorial : 1 hour/week

Practicals : 2 hour/week

Assessment:

Theory:

Continuous Assessment – 25 marks (25%)

1. Assignment – 5 marks.
2. Mid Term Test – 10 marks.
3. Class Test/Surprise Test/Quizzes – 10 marks.

Semester End Examination – 50 marks (50%)

Written Examination (3 hours) – 50 marks

Practicals:

Continuous Assessment – 25 marks (25%)

1. Regular Assessment of Experiments –15 marks
2. Class Test/Practical Examination/Viva Voce – 10 marks

Subject Matter:

PART – A: Building Materials

1. **Building Stones and Bricks and Clay Products and Lime**:

   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.

   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.

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

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

2. **Timber, Wood Based Products, Glass and Metals:**

   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.

   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.

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

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

3. **Paints and Varnishes, Plastics, Asbestos and Bituminous Materials:**

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.

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

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.

4. **Cement, Mortar and Concrete**:

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.

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 – 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.

Mortars: Types and characteristics of mortar as per IS Code.

PART – B: Building Construction

1. **Components of Building**: Elements of building and their functions – Building bye laws – Modular co-ordination – Types of loads on buildings.
2. **Foundations:** Types of soils – Types of foundations and their selection criteria.
3. **Masonry**: Types of masonry: stone and brick masonry – Plan, elevation, and sections of stone masonry – Different types of brick bonds – Plan, elevation and section of brick bonds up to two brickwall thickness.
4. **Walls**: Types of walls and their design criteria and construction – solid walls, partition walls and cavity walls including damp proofing.
5. **Floors**: Types of floors and their selection criteria and construction.
6. **Plastering, Pointing and Painting:** Types of plastering and pointing and their selection criteria and construction – White (Lime) washing and colour washing – Painting and distempering.
7. **Roofs:** Types of roofs and roof coverings and their selection criteria and construction including water proofing treatment.
8. **Doors and Windows:** Types of doors and windows and their sizes, location and materials including construction.
9. **Vertical Circulation:** Types of stairs and staircases – Materials and proportion, and their selection criteria and construction including fire escape stairs – Lifts and escalators.
10. **Joints:** Types of joints: expansion and contraction, and their location and construction.
11. **Form Works:** Centering and shuttering: their selection and construction – Types of scaffolding, their selection criteria and construction.
12. **Sound and Fire Proof Construction:** I.S.Code specifications – Selection criteria and construction of sound and fire proof constructions.

Practicals:

At least minimum of ten experiments has to be conducted from the following:

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. Load-Deflection curve and measurement of strains by mechanical and electrical strain gauge for a steel beam/concrete beam.
10. Bond strength between steel bar and concrete (a) in a beam specimen and (b) by pull out test.
11. Demonstration of the use of non-destructive test equipment.
12. Concrete Mix Design as per I.S. Code Method.
13. Site visits to on-going construction works in the local area to show the scaffolding and formworks etc.

Reading List:

1. Technical Teachers' Training Institue, Chandigarh, (2006). *Civil Engineering Materials*, Delhi: Tata-McGraw-Hill.
2. Rangwala, S.C., (2006), *Building Materials* (3rd ed.),Delhi: Charotar Publications.
3. Surendra, S., (1979), *Engineering Materials*, Delhi: Konark Publishers.
4. Kulkarni, C.J., (1974). *A Text Book of Engineering Materials* (9th ed.), Ahmedabad: Book Depot.
5. Kumar, S., (1994). *Engineering Materials*, Delhi: Standard Publishers & Distributers.
6. Shetty, M. S., (1994). *Concrete Technology*, Delhi: New Age International Publishers.
7. Gambhir, M. L., (2002). *Concrete Technology*, Delhi: TMH Publishers.
8. Varshney, R. S. (1982). *Concrete Technology*, Delhi: Oxford and IBH Publishing Co.
9. Sastry ,V.V.N. and Gambhir, M.L. *Concrete Laboratory and Practice*, Delhi: Dhanpath Rai and Sons,.
10. Smith, R.C. *Materials of Construction*, New York: McGraw-Hill Company.
11. Arora, S.P. and Bindra, S.P, (1997). *A Text Book of Building Construction*, Delhi: Dhanpat Rai Publications.
12. Punmia, B.C., (1997). *Building Construction*, Delhi: Lakshmi Publications.
13. Kulkarni, C.J., (1968). *A Text Book of Engineering Construction*, Ahmedabad: Ahmedabad Book Depot.
14. Kumar, S., (1994). *Engineering Construction*, Delhi: Standard Publishers & Distributers.
15. Jha, J., and Sinha, S.K., (2004). *Building Construction*, Delhi: Khanna Publishers.
16. Mckay, W.B. *Building Construction* (vol.1 to 4).
17. Cecil, C. H. *Building Materials*, London: The Architectural Press.
18. Melrin, N. *Text-Book of Engineering Materials*, New York: John Wiley & Sons Inc.

Date : June 2011.

Semester IV

Name of the Module	**:**	Engineering Mathematics-IV
Module Code	**:**	MAT24
Semester	**:**	IV
Credit Value	**:**	12
Module Leader	**:**	Mr. Jayachandran V
Module Tutor	**:**	Jayachandran V and S.T. Venkatesan,

General objectives or aims of the module:

To introduces students the mathematical techniques to solve engineering problems using Z-transforms Fourier Transforms and Special Functions. To give students a basic knowledge in Probability Theory and Statistical Concepts.

Learning outcomes:

Upon successful completion of this module, the students will be able to demonstrate knowledge and understanding of:

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. Compute the definite integrals using the Beta and Gamma function.
4. Solve the ODE by Power series and Ferbenius Method.
5. Explain the performance of Bessel functions and to solve the Sturn-Liouville problem.
6. Explain the significance of Probability theory and Statistical concepts, by means of essential definitions and standard distributions with appropriate examples and applications.
7. Apply the relation between linear maps and matrices and how properties of either influence the solvability of systems of linear equations.
8. Apply the basic working knowledge of Mathematical methods in Fourier Transform in engineering situations
9. Apply Z-transform in engineering problems.

Learning and teaching approach used:

- Lectures : 4 hours/week
- Tutorial : 1 hr/week

Assessment:

Continuous Assessment - 30 marks (30%)

1. Assignment - 10marks.
2. Mid Term Test - 10marks.
3. Class Test - 10marks.

Semester End Examination - 70 marks (70%)

1. Written examination (3 hrs) – 70 marks

Subject matter:

1. **Special functions series solution of differential equations:** Introduction: Series solution validity of series solution. Power Series Method and Ferbenius Method for solving ODE. Bessel Equation, Recurrence Formula for fn(x). Expansion for Jo and J1-values of J1/2. Generating Function for Jn(x). Equations reducible to Bessel's Equation. Orthogonality of

Bessel Functions. Fourier Bessel expansion of f(x), Ber and Bei functions. Legerdre's equation. Rodriguez's Formula Legendre's Polynomials. Generating Function for Pn(x). Orthogonality of Legendre's Polynomials, Fourier-Legendre expansion of f(x). Other Special Functions Laguerre's Polynomials. Chebyshev. Polynomials. Beta and Gumma functions. Error functions

2. **Statistics and Probability:** Measures of central tendency, Measures of Disperson. Correlation (including Rank correlation) and regression. Sample Spaces, Axioms of Probability, Conditional Probability, Standard Distributions and z-Distribution. Joint Probability Distributions, Sampling Distributions, Point and Interval Estimation.
3. **Fourier Transforms:** Introduction, Definition of Integral Transforms. (Laplace, Fourier, Mellin transforms). Fourier Integral Theorem. Fourier Sine and Cosine Integrals. Complex forms of Fourier Integrals. Fourier Integral representation of a function. Fourier Transforms. Fourier Sine and Cosine Transforms. Finite Fourier Sine and Cosine Transforms. Properties of Fourier Transforms Convolution Theorem. Parseval's Identity. Relation between Fourier and Laplace Transforms. Fourier Transforms of derivatives of a function. Inverse Laplace Transforms by method of Residues.
4. **Z-Transformation**: Definition, Standard Z-Transforms, Damping Rule, change of scale and shifting property, multiplication and division by K, Inverse z-transforms, Convolution Theorem, Convergence of Z-tranforms and application to Differential Equation.

Reading list

1. Erwin Kreyszig (2002), "Advanced Engineering Mathematics", 8th edition, John Wiley & Sons (Asia) Pvt Ltd, Singapore.
2. Dr. B.S.Grewal (2001), "Higher Engineering Mathematics", 36th edition, Khanna Publishers, New Delhi.
3. H.K.Dass (2005), "Advanced Engineering Mathematics", 14th edition, S.Chand & Company Ltd, New Delhi.
4. R.K.Jain and S.R.K.Iyengar (2003), "Advanced Engineering Mathematics", 2nd edition, Narosa Publishing house, New Delhi.
5. I.B.Prasad (1982), "Practical Mathematics Vol I and Vol II", 6th edition, Khanna Publishers, New Delhi.
6. Shanti Narayan (1994),"Theory of functions of a Complex Variables", 7th edition, S.Chand & Company Ltd, New Delhi.
7. Murray R. Spiegel (1980), "Theory and Problems of Probability and Statistics", Schaum's Outline Series, McGraw-Hill Book Company, Singapore.
8. Surjit Singh, "Linear Algebra", Vikash Publishing House Pvt Ltd, India.

Date: June 2011

Name of the Module : Hydraulics
Module Code : FMH203
Semester : IV
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General Objective of the Module:

The objective of this module is to provide the student with an understanding of hydraulics as applied to the environmental civil engineering works and to understand the working principles of various types of hydraulic machines.

Learning Outcomes:

Upon successful completion of this module the students will be able to:

1. Solve uniform open channel flow problems.
2. Apply dimensional analysis and similitude in order to account for the implications of scale in model experiment.
3. Calculate depth profiles in channels with steady gradually-varied flow.
4. Understand the working principles of various hydraulic machineries.
5. Identify flow types in open channel flow.

Learning and Teaching Approach Used:

Lectures introduce concepts and provide a broad background and demonstrations are used to clarify particular points of detail. Laboratory sessions are conducted to develop practical skills and awareness of practical application of subject material. Direct reading and assignments are used to help students to monitor their own progress through the module.

Lectures: 3 hrs/ week

Tutorial: 1 hr/week

Laboratory practical: 2 hrs /week

Assessment:

Theory:

Continuous assessment – 25 marks (25%)

1. Assignment – 5 marks.
2. Mid term Test – 10 marks.
3. Class test – 1 0 marks.

Semester End Examination – 50 marks (50%)

Written examination (3 hours) – 50 marks.

Practicals:

Continuous Assessment – 25 marks

1. Regular assessment of the experiments – 15 marks.
2. Practical examination/quiz/viva voce – 10 marks

Pre-requisite: Engineering Mechanics & Fluid Mechanics.

Subject Matter:

1. **Flow in Uniform Open channels:** Types of flow in channel – Geometric properties of a channel section – velocity distribution – Uniform flow – Ganguillent-Kutter Formula – Bazin's formula, Chezy's formula and Manning's formula – Most economical section of channel: rectangular, trapezoidal, triangular and circular channel sections – Computation of uniform flow – Specific energy and critical depth – Momentum in open channel flow –specific force – Critical flow and its computation – Application of specific energy and discharge diagrams to channel transitions – Mean velocity of flow in channels –Measurement of discharge in rivers.
2. **Non-Uniform flow in Open Channels:** Gradually varied flow – Classification of channel bottom profiles and surface profiles – Characteristics of surface profiles – Hydraulic jump in

rectangular channels – Types of hydraulic jump and its location – Simple waves and Surges in open channels.

3. **Dimensional Analysis, Hydraulic Similitude and Model investigation:** Dimensions – Dimensional homogeneity – Raleigh and Buckingham's π theorems, applications – Model investigation – Similitude - Geometric, kinematics and dynamic similarities – Dimensionless numbers – Model laws – Types of models – Merits and limitations of distorted models –Scale effect – Application of dynamic similarity in model investigations.
4. **Impact of Free Jets:** Force exerted by fluid jet on stationary flat plate, moving plate, stationary curved vane and moving curved vane – Angular Momentum Principle – Torque exerted on a wheel with radial curved vanes.
5. **Hydraulic Turbines:** Elements of Hydroelectric turbines – Head and efficiencies of hydraulic power plants – Classification of turbines – Pelton wheel – Work done and efficiency – Construction details of Pelton turbine runner – Multiple jet Pelton wheel –Reaction turbines – Francis turbine – Work done and efficiency – Construction details of runner – Draft tube Theory – Kaplan turbine – Governing of turbines – Runaway speed –Surge tanks – Performance of turbines – Performance under unit head – Unit quantities – Performance under specific conditions – Specific speed – Performance characteristic curves – Model testing of turbines – Cavitation – Selection of turbines.
6. **Reciprocating Pumps:** Main components and working principle – Different types – Work done by a single-acting pump and double-acting pump – Coefficient of discharge – Percentage of slip – Negative slip – Effect of acceleration of piston on velocity and pressure in the suction and delivery pipes – Indicator diagrams – Air vessels – Multi-cylinder pumps.
7. **Centrifugal Pumps:** Components and working – Different types – Work done by the impeller – Head, losses and efficiencies – Minimum starting speed – Specific speed - Model testing of pumps – Multi-stage pumps – Pumps in parallel – Performance of pumps – characteristic curves – Limitation of suction lift – Cavitation – Priming devices – Centrifugal pumps troubles and remedies.

Practical:

1. Determination of Manning's roughness coefficient.
2. Flow over broad crested weir
3. Flow over sharp crested weir
4. Flow in Venturi flume.
5. Hydraulic jump
6. Determination of discharge using float
7. Study of impact of jets.
8. Determination of characteristic curves and specific speed of a Pelton turbine.
9. Determination of characteristic curves and specific speed of a Francis turbine.
10. Determination of characteristic curves and specific speed of a Centrifugal pump.

Reading Lists:

1. Modi, P.N. and Seth, S.M., (2000). *Hydraulics and Fluid Mechanics including Hydraulic Machines* (14th ed.), Delhi: Standard Book House.
2. Bansal, R.K., (2008). *A Text Book of Fluid Mechanics and Hydraulic Machines*, Delhi: Laxmi Publication.
3. Jain, A.K., (2007). *A Text Book of Fluid Mechanics* (9th ed.), Delhi: Khanna Publishers.
4. Khurmi, R. S., (1988). *A Textbook on Hydraulics* (16th ed.), Delhi: S Chand & Company.
5. Jagdish, L., (2002). Fluid Mechanics & Hydraulics (9th ed.), Delhi: Metropolitan Book Co.

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

Date: June 2011

Name of the Module : Principle of Surveying – II
Module Code : SUR202
Semester : IV
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Mr. Tshering Tobgyel

General objectives or aims of the module:
To introduce concepts of geodetic surveying and applications of modern surveying techniques.

Learning outcomes:
The students should know the following upon successful completion of the module:

1. Perform triangulation surveying.
2. Understand the causes of errors in surveying and apply adjustments.
3. Set out horizontal curves by different methods.
4. Carry out setting out of building and location of bridge piers.
5. Conduct traversing by total station
6. Conduct topographical survey by total station

Learning and teaching approach used

Lectures will be used as the basic method of introducing concepts and this will be reinforced by tutorials to gain analytical skills. Practical classes are provided to give experience on the use of various instruments. These skills be provided by the following means;

Lectures : 2 hrs/Wk

Tutorial : 1 hrs/Wk

Laboratory practical: 3hrs/Wk

Assessment

Continuous assessment – 50 marks (50%)

Theory – 25 marks (25%)

1. Midterm exam - 10 marks
2. Assignment – 10 marks
3. Case Study – 5 marks

Practical – 25 marks (25%)

1. Assignment - 20 marks
2. Test - 5 Marks

Semester End Examination – 50 marks (50%)

Written examination (3hrs) - 50 Marks

Pre-requisite: POS201– Principles of Surveying –I

Subject matter:

Theory:

1. **Triangulation:** Triangulation system, strength of figures, selection and intervisibility of stations, signals & towers, base line measurement, reduction to mean sea level, satellite stations, reduction to centre.
2. **Adjustment Computation:** Theory of errors and triangulation adjustments- types of errors, principle of least squares, laws of weights, normal equations, method of correlates, station and figure adjustments.
3. **Curves:** Classification of curve, elements of circular curves, theory and methods of setting out simple horizontal and vertical curves.
4. **Project Surveys:** location surveys- for buildings, highways and bridges.
5. **Introduction to Minor Instruments:** Planimeter, Pentagrapgh, spinnometer, altimeter.
6. **Introduction to Modern Surveying:** Total Station- parts of total station, horizontal and vertical angle measurements, adjustments, observation of readings, data processing procedures, GPS-parts of GPS, observation of readings, data processing procedures.

Practicals:

1. To carry out Triangulation on a given area.
2. To compute the adjusted coordinates of Triangulation Stations.
3. To plot the coordinates at a given scale on plane Table and their field checking.
4. Layout a simple horizontal and vertical circular curves
5. Layout of building.
6. Conduct exercise using minor instruments.
7. Conduct traversing by using total station
8. Conduct topographical survey using total station.

9. Setting out works using Total Station

Reading list:

1. Agor. R, (2000), *Surveying vol.II* (3rd ed.), Delhi: Khanna publications.
2. Arora R, (2000), Surveying vol. II, (3rd ed.), Delhi: Khanna publications.
3. Duggal, S. K. (2007). Surveying –II, (2nd ed.), Delhi: Tata Mcgraw Hill.
4. B.C.Pumia. (2000). Surveying -II (3rd ed.) , Delhi: Laxmi Publications
5. Rangwala, S.C. (2005). Surveying and levelling, (2nd ed.), Delhi: Charotar Publishing House.

Date : June 2011

Name of the Module : Engineering Geology
Module Code : BPD202
Semester : IV
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:

To introduce the application of geologic science to engineering practice to enable the students to recognize the geologic factors that affects the location, design, construction, operation and maintenance of engineering works.

Learning outcomes:

Upon successful completion of this course the student will be able to;

1. Identify and classify various rocks and minerals
2. Measure the strength of various rocks
3. Identify earthquake prone areas
4. Classify, monitor and measure landslides and subsidence
5. Prepares and interpret Engineering Geologic maps
6. Analyze ground conditions through geophysical surveys
7. Investigate sites for civil Engineering projects.

Learning and teaching approach used

The learners will be engaged with theory and laboratory practical. Examples will be used to clarify salient features and to illustrate the concepts. Relevant experiments will be conducted to consolidate the various concepts introduced in this module based on the indicative hours given below:

Lectures : 2 hrs/wk
Practical : 2 hrs/wk

Assessment: The achievement of the learning outcomes is assessed in the following manner.

Theory:

Continuous assessment – 25 marks (25%)

Assignment - 10 marks.

Mid term test – 10 marks.

Project – 5 marks

Semester End Examination – 50 marks (50%)

Written examination (2hrs) - 50 marks

Practicals:

Continuous assessment - 25 marks (25%)

Regular assessment of the experiments – 15 marks.

Practical examination/quiz/viva voce – 10 marks

Pre-requisite: None

Subject matter:

Theory:

1. **Introduction:** Branches of geology, Engineering Geology and applications
2. **The Earth as a System:** universe, solar system, parts of earth, composition of atmosphere, Lithosphere, Hydrosphere, Cryosphere and Atmosphere and their interactions.
3. **The Solid Earth:** Shape, size and interior of the solid earth, minerals, importance of rock forming minerals, geological agents-exogenous and endogenous agents, rock cycles, Igneous rocks-classification, structures, textures, types and methods to identify igneous rocks, sedimentary rocks-classification, structures, textures, types and methods to identify sedimentary rocks, metamorphic rocks- classification, structures, textures, types and methods to identify metamorphic rocks.
4. **Earth Processes and their consequences:** out crops, strike, dip, folds-types, parts , evidences and effects, faults-types, parts, evidences and effects, joints-effects of joints, importance of geological structures.
5. **Earthquakes:** Plate tectonics, classification, seismic belts, magnitude, intensity, historical earthquakes, earthquake processes, earthquake waves, determination of epicentre, earthquake prediction, earthquake protection.
6. **Landslides and subsidence:** mass movement, classification, causes, immediate causes, measures, classification and monitoring;
7. **Geological mapping:** Geological time sacle, time unit vs rock units, toposheet reading, geologic map reading and preparation of geologic maps.
8. **Stratigraphy:** Geology of Bhutan- different geological zones.
9. **Geophysical mapping:** seismic, electrical, magnetic, acoustic, resistivity and gravitational methods.
10. **Site investigation and selection:** Desk Study, Boreholes, introduction to GIS and GPS.

List of Experiments for 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.

Reading list

1. Kesavulu, N. C. (2009). *Textbook of Engineering Geology,* (3rd ed.*)*, Delhi: Macmillan Publisher.
2. Kesavulu. N.C. (1993). *Text book of Engineering Geology*, (2nd ed.), Delhi: Macmillan Publisher.
3. Tony W. (2001). *Foundations of Engineering Geology, (1st ed.),* New York: Chapman & Hall.
4. Singh. P. (2003). *Engineering and General Geology*, (6th ed.), Delhi: S.K. Kataria and Sons.
5. Reddy,M.T. M. (2002). *Engineering geology practical*, (2nd ed.), Delhi: New Age International.
6. John R. J. (2003). *Remote Sensing of the Environment and Earth Resource Perspective*, (1st ed.), Delhi: Pearson Education.

Date: June 2011

Name of the Module : Structural Mechanics-I
Module Code : TSM202
Semester : IV
Credit Value : 12
Module Leader : Ms. Monika Thapa
Module Tutor : Ms. Monika Thapa and Dr. Cheki Dorji

General objectives or aims of the module:
To introduce various methods for the analysis of determinate and indeterminate structures.

Learning outcomes:
Upon the successful completion of this course, the 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. Analyse the indeterminate beams, frames using method of consistent deformations, slope deflection method, moment distribution method, rotation contribution method.
4. Analyse the indeterminate beams, frames using energy theorems.
5. Determine the deflection of perfect frames by Castigliano's theorem, unit load method and Max well's reciprocal theorem.

Learning and teaching approach used
The concepts of the various principles are introduced through lectures with examples and their application to real time problems. The students are encouraged to study on their their own to consolidate the concepts and understanding of the principles involved in the analysis of structures under different loading conditions through tutorials/assignments. The time allocated for these activities is given below:

Lectures : 3 hours/week
Tutorial : 1 hour/week

Assessment:

Continuous assessment - 30 marks (30%)

1. Assignment – 10 marks.
2. Mid term Test- 10 marks.
3. Class test/ surprise test/ quizzes- 10 marks.

Semester End Examination - 70 marks (70%)

Written examination (3 hours) – 70 marks.

Pre-requisites: TSM101 – Engineering Mechanics and TSM201 – Strength of Materials.

Subject matter:

1. **Introduction to Structural Analysis:** Forms of structures, loads and forces, idealization of structures, elastic and linear behavior of structures, principle of superposition, support and connection, analysis of determinate structures.
2. **Analysis of Indeterminate Beams and Frames:** Reaction components, external redundancy, statically indeterminate beams, degree of redundancy of articulated structures, degree of redundancy of rigid jointed frames, methods of analysis.
3. **Method of Consistent Deformation:** Unit load method, Maxwell's Reciprocal Theorem applied to Perfect frames, statically **i**ndeterminate beams and frames, Betti's reciprocal theorem.
4. **Slope Deflection Method:** Fundamental Equations, Continuous beams and frames without and with joint translation, Portal Frames without and with side sway.
5. **Moment Distribution Method:** Fundamental Proposition, Continuous beams and frames without and with joint translation, Portal Frames without and with side sway, sinking of supports.
6. **Rotation Contribution Method (Kani's Method):** Fundamental Proposition, Continuous beams and frames without joint translation, Portal Frames without and with side sway.
7. **Energy Theorems:** Deflection by Castigliano's theorem, analysis of statically indeterminate beams, frames and redundant frame by minimum strain energy and principle of virtual work.

Reading List:

1. Redd, C.S. (2008). *Basic Structural Analysi,* (4th ed.). Delhi: Tata Mc.Graw-Hill.
2. Vazirani V.N., &.Ratwani, M.M. (2002). *Analysis of Structures- Vol. I,* (3rd ed.). Delhi: Khanna Publishers.
3. Vazirani V.N., &.Ratwani, M.M. (2002). *Analysis of Structures- Vol. II,* (3rd ed.). Delhi: Khanna Publishers.
4. Ganesan, T. P. (2000). *Model analysis of structures*, (2nd ed.). Delhi: Universities Press
5. Punmia, B.C. (1988). *Strength of Materials and Mechanics of Structures-Vol. II*. Delhi: Standard Publishers & Distributors.
6. Norris, C.H., Wilber, J.H., & Utku, S. (2005). *Elementary Structural Analysis*, (2nd ed.). Delhi: Tata Mc.Graw Hill.
7. Norris, C.H., Wilber, J.H., & Utku, S. (1976). *Elementary Structural Analysis*, Tokyo: McGraw Hill.
8. Rao, D.S.P. (1996). *Structural Analysis- A Unified Approach*, Hyderabad: Universities Press.
9. Coates, R.C., Coutie, M.G., & Kong, F.K. (1980). *Structural Analysis*, Hongkong: ELBS & Nelson.
10. Ramamrutham, S. & Narayan,R. (2002). *Theory of Structures* (3rd ed.). Delhi: Dhanpat Rai Publishing Company.
11. Jindal, R. L. (1986). *Elementary Theory of Structures* (2nd ed.). Delhi: S.Chand & Company.
12. Sinha, N.C. & Gupta S.K., (1987). *Elements of Structural Mechanics*. Delhi: S.Chand & Co.

Date: June 2011.

Semester V

Name of Module	**:**	Entrepreneurship Development
Module code	**:**	MGT301
Semester	**:**	V
Credit value	**:**	9
Module Leader	**:**	Mr. Nima Dukpa
Module Tutor	**:**	Mr. Nima Dukpa

General objective:

This module will instill an entrepreneurial mindset in students by providing basic understanding of entrepreneurship and entrepreneurial skills, opportunities in the country, RGoB's initiatives and supports, and other management practices like financial, materials and project management.

And appreciate the methods of carrying out the economic studies of a project.

Learning outcomes:

At the end of this module, students are expected to be able to:

1. Explain what an entrepreneurship is, what characteristics should a good entrepreneur have.
2. Explain the scope of entrepreneurship in the country and the relation between an entrepreneur and society.
3. Explain basic idea of financial, materials, personnel and project management related to business management.
4. Explain on formation of a company, Licensing procedures and formalities, Sources of information. Incentives, Subsidies and concessions for industry, industrial development agencies and their functions, in Bhutan.
5. Explain basics approaches to identification of opportunities, market survey, break-even analysis, Techno economic feasibility studies and financial viability
6. Carries out economic analysis of a project
7. Calculates depreciation of properties by various methods.
8. Explain basic methods of market survey and analysis, marketing arrangements and strategies, projections, predictions and forecasts market.
9. Explains tax rules and regulations.
10. Prepares business project proposal.

Learning and teaching approach used:

Lectures introduce concepts and provide a broad background; demonstrations are used to clarify particular points of detail or to illustrate concepts. Case studies will used where appropriate. Directed reading and assigned problems develop learning at a pace appropriate to the individual student. Tests and worksheets are used to help students to monitor their own progress through the module.

- Lecture : 2 hours per week
- Tutorial : 2 hours per week

Assessment

- **Continuous Assessment - 30 marks (30%)**

5. Assignment - 10marks

6. Closed book mid Term Test- 15marks
7. Class Test - 5marks

Semester End Examination - 70marks (70%)

6. written examination: 3 hrs (closed book)

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%.

Subject matter:

1. **Introduction to Entrepreneurship**
2. **Introduction to Engineering Economy:** Engineering and Engineering economy, Risk and uncertainty, Equity and debt, capital accounting fundamentals, Elements of cost, flow of capital within a firm.
3. **Economic Environment and cost concept:** Concept of value and utility, consumer and producer goods and services, measures of economic worth, law of supply and demand, law of diminishing return, break even analysis, opportunity cost, classification of cost.
4. **Money – Time relationship:** Simple interest, compound interest, annuity series, cash flows over time
5. **Methods of making economic studies:** Payback period, Accounting rate of return, Internal rate of return, Benefit cost ratio or profitability index, Sensitivity analysis, Statistical methods, NPV
6. **Depreciation**: Purpose, methods of depreciating, accounting for the depreciation of capital assests, valuation.
7. **Financial Management and Accounting Concepts:** Book keeping; Financial Statements Analysis; Financial Ratios, Capital Budgeting, Break even Analysis; RGoBs' Procurement Procedures.
8. **Setting up an Industry:** Formation of a company, Licensing procedures and formalities, Sources of information. Incentives, Subsidies and concessions for industry, industrial development agencies and their functions.
9. **Project Planning:** Identification of opportunities, market survey, break-even analysis, Techno economic feasibility studies, and financial viability.
10. **Marketing:** Market survey and analysis, marketing arrangements and strategies, projections, predictions and forecasts market feedback. Marketing Environment; Consumer Markets and Buyer Behavior; Marketing Mix, Advertising and Sales Promotion; Channels of Distribution
11. **Business and Industrial Laws:** Labour laws, income tax, excise duty, sales Tax
12. **Project Report:** Preparation of a detailed project report.

Reading List:

1. Chand Tara, *Engineering Economics vol-I*, 8th edition, Nem Chand & Bros, Roorkee (U.P).
2. DeGarmo E Paul, Sullivan William G, Canada John R, *Engineering Economy*, 7th edition, Macmillan Publishing Company, New York.
3. Banga T R, Sharma S C, *Industrial Organisation & Engineering Economics*, 18th edition, Khanna Publishers, Delhi.
4. Case Karl E, Fair Ray C, *Principles of Economic*, 6th edition, Pearson Education Asia.
5. Brandt Steven C, *Entrepreneuring*, 3rd edition, Macmillan India Ltd.
6. Dollinger Marc J, *Entrepreneurship*, 3rd edition, Pearson Education.
7. Coulter Mary, *Entrepreneurship in Action*, 2nd edition, PHI, Delhi.

8. Banga T.R., (1990), *Project Planning & Entrepreneurship Development*, CBS Publishers, New Delhi.

Date: June 2011

Name of the Module	**:**	Numerical Analysis and Optimization
Module Code	**:**	MAT301
Semester	**:**	V
Credit Value	**:**	9
Module Leader	**:**	Mr. S.T. Venkatesan
Module Tutors	**:**	Mr. S.T. Venkatesan

General objectives or aims of the module:
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 analyzing the behavior of simplex method and to illustrate how the techniques would be applied in practical settings.

Learning outcomes:
At the end of this module, students are expected to be able to:

1. Fit the data to the appropriate curve by the method of least squares and use the appropriate interpolation formula to find the missing data.
2. Make use of knowledge and understanding to use Eigen value methods to determine critical conditions for solutions of equations.
3. Solve system of linear equations numerically and to evaluate critically different approaches and techniques for their implementation.
4. Solve numerical differentiation, numerical integration, O. D. E's using numerical techniques, having critically appraised different techniques and select the most appropriate.
5. Consider a range of mathematical methods and select the most appropriated to determine the solution of a range of engineering problems.
6. Compare the performance between different methods and able to manipulate any numerical problem.
7. Tackle a wide range of mathematical problems using modern numerical methods. They will not only be able to model realistic situations but also understand the principles underlying the techniques and when they are applicable.
8. Acquire an appreciation of a key area of industry / commercial management.
9. Further develop Problem formulation and problem solving skills.
10. Solve the numerical problems using Matlab/ C++

Learning and teaching approach used

Lectures	:	2 hours per week
Tutorial	:	1 hour per week
Practical	:	1 hour per week

Assessment
Continuous Assessment Theory - 25 marks

1. Assignment	-	10marks
2. Closed book mid Term Test	-	10marks
3. Class Test	-	5marks

Continuous Assessment Practical - 25 marks

Semester End Examination - 50marks

3 hrs written examination (closed book)
Students must obtain 40% each in the Continuous assessment of theory and Practical and the semester end examination. The overall pass mark for the module is 50%.

Subject matter
Numerical Analysis with Programming:

1. **Curve fitting**: by the method least squares fitting of Straight line, Second degree parabola and Exponential curve
2. **Interpolation:** Forward, Backward and central differences. Newton's forward and backward interpolation formula, Gauss's forward and backward, and Stirling's interpolation formula, Lagrange interpolation. Divided differences.
3. **Numerical Differentiation**: Numerical differentiation at the tabulated points with forward, backward and central differences.
4. **Numerical integration:** Trapezoidal rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule, Romberg's integration.
5. **System of linear Algebraic equations**: System of linear equations: Gauss's elimination method, gauss's Jordan elimination method. Gauss Seidal iteration method and Jacobi's iteration method. Calculation of dominant Eigen value by Power method and Jacobi's method. Solution of Non linear equations: Numerical solution of algebraic and transcendental equations by Regula- Falsi method. Newton-Raph Son's method.
6. **Numerical solution of first order ordinary differential equations:** Euler's method, Modified Euler's method, Taylor Series method, Runga-Kutta method of 2^{nd} and 4^{th} orders.
7. **Introduction to Linear Programming:** Introduction: Engineering applications, Statement of the problem, classification of optimization problems and optimization techniques; Classical optimization Techniques: Single variable, multivariable with no constraint, with equality constraints and with inequality constraints; Linear Programming I : Graphical, Simplex method – solution of a system of linear simultaneous equations, pivotal reduction of a general systems of equations.
8. **Solve all the above problems using matlab/c++**

Reading list

1. Dr.B.S.Grewal (2003), "Numerical Methods in Engineering & Science", 6^{th} edition, Khanna Publishers, NewDelhi, India.
2. M.K.Jain, S.R.K.Iyengar, and R.K.Jain (2002), "Numerical Methods Problems and Solutions", New Age International (P) Ltd Publishers, New Delhi.
3. Hamdy A. Taha (2006), "Operations Research an Introduction", 7^{th} edition, Prentice-Hall of India private Ltd.
4. Singiresu S. Rao (1998), "Engineering Optimization Theory and Practice", 3^{rd} edition, New Age International (P) Ltd, Delhi.

Date: June 2011

Name of the Module	: Soil mechanics
Module Code	: FED301
Semester	: V
Credit value	: 12
Module leader	: Mr. Sabuar Rahman

Module Tutor : Mr. Sabuar Rahman and Dr. Cheki Dorji

General objectives:

To acquaint students with the basic concepts and fundamentals in Soil mechanics and their applications to civil engineering problems.

Learning outcomes:

Upon successful completion of this course student will be able to

1. Identify the soils based on their index properties.
2. Classify different types of clay minerals with their structures.
3. Determine field control measures for compaction.
4. Compute effective stress and total pressure.
5. Compute the coefficient of permeability of different types of soil.
6. Analyze seepage through soils.
7. Conduct 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 used:

Lectures introduce basic concepts, demonstration of experiment and procedure to conduct the experiments and record readings. Practical examples are used to clarify salient features in detail or to illustrate concepts. Tutorial sessions are conducted to develop problem solving skills and awareness of practical application of the subject matters. Directed reading and assigned problems develop learning at a pace appropriate to the individual student. Tests and worksheets are used to help students to monitor their own progress in the module.

Lecture: 3 Hrs./wk

Tutorial: 1 Hr./wk

Practical: 2 Hrs/wk

Assessment

Theory:

Continuous assessment - 25 marks (25%)

1. Assignments - 10 marks.
2. Mid term test - 10 marks
3. Class test - 5 Marks

Semester End Examination - 50 marks (50%)

Written examination: 3 hrs duration

Practical:

Continuous assessment - 25 marks (25%)

1. Evaluation of regular practical works: 15 marks.
2. Internal Practical examination/ viva-voce: 10 Marks

Pre-requisite: TSM201 Strength of materials, BPD202 Engineering Geology

Subject matter:

Theory:

1. **Introduction:** Introduction to Geotechnical Engineering, Unique nature of soil, Origin & Formation of soil.
2. **Simple soil properties:** Basic definitions, phase relations, functional relationship between different parameters, index properties of soil including consistency limits & grain size distribution.
3. **Identification & Classification of Soil:** Indian standard classification system of soil, clay minerals (basic concept) & soil structure, visual identification of soil.
4. **Compaction Behavior:**, Compaction- theory of compaction, laboratory compaction tests, different methods of compaction control.
5. **Principle of effective stress and relative phenomenon:** Soil water, capillarity of soil, principle of effective stress, total pressure, and neutral pressure, quick sand.
6. **Permeability:** One dimensional flow, permeability of soil- Darcy's law, laboratory methods of determination, permeability as a function of soil type, permeant void ratio, soil fabric, & effective stress, pumping out tests for field determination of permeability.
7. **Seepage through soils:** 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, piezometric head, elevation head.
8. **Vertical stresses below applied load:** 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
9. **Compressibility & Consolidation:** Effects of soil type, stress history and effective stress on compressibility, consolidation- factors affecting consolidation and compressibility parameters, normally consolidated and over consolidated soil, 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.
10. **Shear Strength behavior:** 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.

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 List:

1. Murthy. V.N.S. (2002). *Principles of soil mechanics and foundation engineering, (3rd ed.),* Delhi: UBS Publishers Distributors.
2. Punmia, B.C. (2009). *Soil mechanics & Foundation,* (4th ed.), Delhi: Laxmi Publication.
3. Murty, V. N. S. (2009). *Textbook of soil mechanics and foundation engineering: geotechnical engineering series,* (2nd ed.), *Delhi:* CBS Publishers.
4. Arora, K. R. (2009). *Soil mechanics and foundation engineering: geotechnical engineering, (3rd ed.),* Delhi: Standard Publishers.
5. Kazimi, S. M. A.(2003). *Soil mechanics*, (2nd ed.), Delhi: Tata McGraw Hill.
6. Kaniraj. S.R. (2008). *Design aids in soil mechanics and foundation engineering, (2nd ed.),* Delhi: Tata McGraw Hill.
7. Oza. H.P. (1969). *Soil mechanics and foundation engineering* (1st ed.), Delhi: Charotar Book Stall
8. Bharat. S. and Shamshor. P. (1976). *Soil mechanics and foundation engineering* (1st ed.), Roorkee, Nem Chand and Bros.
9. Gopal. R. and Rao, A . S . R. (2006). *Basic and applied soil mechanics*, (3rd ed.), Delhi: New Age International Publisher.
10. Mittal. S. (2008). *Soil Testing for Engineers*, (1st ed.), Delhi: Khan a Publication.
11. Coduto. D.P. (2006). *Geotechnical engineering*, (2nd ed.), Delhi, Prentice-Hall.
12. Kramer. S. L. (2006), *Geotechnical earthquake engineering*, (2nd ed.), Delhi, Pearson Education.
13. Alam.S. (2004). *Modern geotechnical engineering,* (2nd ed.), Delhi: CBS Publishers.
14. Alam.S. (2004). *Basic soil mechanics and foundations*, (1st ed.), Delhi: CBS Publishers.
15. Gulhati. S. K and Datta. M. (2006). *Geotechnical engineering*, (2nd ed.), Delhi, Tata McGraw Hill.
16. Holtz. R. & Kovacs. W.D. (1981). Introduction to Geotechnical Engineering, New York: John Wiley and Sons.
17. Lambe. T.W. and Whitman, R.V. (1969). Soil Mechanics, (1st ed.). New York: John Wiley & Sons.
18. Terzaghi. K. & Peck. R.B. (1968). *Soil Mechanics in Engineering Practice*, New York: John Wiley and Sons.

Date: June 2011

Name of the Module : Structural Mechanics-II
Module Code : TSM301
Semester : V
Credit Value : 12
Module Leader : Ms. Monika Thapa
Module Tutor : Ms Monika Thapa and Dr. Cheki Dorji

General objectives or aims of the module:

To introduce column analogy, matrix and influence lines methods for analysis of fixed beams, portal frames, columns, arches and suspension bridges.

Learning outcomes:

Upon the successful completion of this course, the students will be able to:

1. Determine behaviour of structures due to moving loads.
2. Draw the influence line diagrams for various types of moving loads on beams.
3. Analyse the indeterminate beams, frames using column analogy method.
4. Analyse the simple structures using matrix method.
5. Analyse the various types of arches for different loads as well as support conditions.
6. Analyse the various types of suspension bridges for different loads as well as support conditions.
7. Determine the collapse load using plastic method of analysis.
8. Explain the basic parameters of theory of elasticity.

Learning and teaching approach used

The concepts of the various principles are introduced through lectures with examples and their application to real time problems. This will be is followed by solving few typical problems. The students are encouraged to study by their own on various imaginary problems and practical problems to consolidate their concepts and understanding of the principles involved in the analysis of structures under different loading conditions through tutorials/assignments. The time allocated for these activities are given below.

Lectures : 3 hours/week

Tutorial : 1 hour/week

Assessment:

Continuous assessment - 30 marks (30 %)

1. Assignment – 10 marks.
2. Mid term Test- 10 marks.
3. Class test/ surprise test/ quizzes- 10 marks.

Semester End Examination - 70 marks (70%)

Written examination (3 hours) – 70 marks.

Pre-requisites: CE 404 – Structural Mechanics-I.

Subject matter:

1. **Column Analogy Method:** Development of Column Analogy Method and its application for the analysis of Fixed Beams, Portal Frames, Closed Frames and Gable Frames.
2. **Introduction to Matrix Method Analysis:** Matrix Method analysis of structures by flexibility or force method, Development of matrix for pin jointed truss by stiffness or displacement method of analysis. Its application to simple Indeterminate beams and frames.
3. **Rolling loads and Influence Lines:** Single concentrated load, UDL longer than the span of girder, UDL shorter than the span of girder, Influence Line Diagrams (ILD) for SF and BM for Beams, Girder with beams, Muller-Breslau's Principle and its applications.
4. **Arches:** 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.
5. **Suspension Bridges:** Equation of Cables, Cables and Suspension bridges, Stiffening girders-three and two hinged stiffening girders, ILD for three hinged and two hinged stiffening girders.

6. **Plastic Analysis**: Plastic moment, Plastic hinge, Load factor, Method of Analysis, Plastic analysis for beams and portal frames, Determination of collapse load for some standard case of beams.
7. **Elementary theory of Elasticity:** State of stress at a point; stress tensor, strain tensor, compatibility equation, equilibrium equation, Generalized Hook's Law, Boundary conditions.

Reading List:

1. Reddy, C.S. (2008). Basic Structural Analysi, (4th ed.). Delhi: Tata Mc.Graw-Hill.
2. Vazirani V.N., &.Ratwani, M.M. (2002). Analysis of Structures- Vol. I, (3rd ed.). Delhi: Khanna Publishers.
3. Vazirani V.N., &.Ratwani, M.M. (2002). Analysis of Structures- Vol. II, (3rd ed.). Delhi: Khanna Publishers.
4. Ganesan, T. P. (2000). Model analysis of structures, (2nd ed.). Delhi: Universities Press
5. Punmia, B.C. (1988). Strength of Materials and Mechanics of Structures-Vol. II. Delhi: Standard Publishers & Distributors.
6. Norris, C.H., Wilber, J.H., & Utku, S. (2005). Elementary Structural Analysis, (2nd ed.). Delhi: Tata Mc.Graw Hill.
7. Norris, C.H., Wilber, J.H., & Utku, S. (1976). Elementary Structural Analysis, Tokyo: McGraw Hill.
8. Rao, D.S.P. (1996). Structural Analysis- A Unified Approach, Hyderabad: Universities Press.
9. Coates, R.C., Coutie, M.G., & Kong, F.K. (1980). Structural Analysis, Hongkong: ELBS & Nelson.
10. Ramamrutham, S. & Narayan,R. (2002). Theory of Structures (3rd ed.). Delhi: Dhanpat Rai Publishing Company.
11. Jindal, R. L. (1986). Elementary Theory of Structures (2nd ed.). Delhi: S.Chand & Company.
12. Sinha, N.C. & Gupta S.K., (1987). Elements of Structural Mechanics. Delhi: S.Chand & Co.

Date : June 2011

Name of the Module : Design of Steel Structures-I
Module Code : DOS301
Semester : V
Credit Value : 12
Module Leader : Mr. Ugyen Tenzey
Module Tutor : Mr. Ugyen Tenzey & Mr. Ugyen Dorji

General objectives:

The general objective of this course is intended to provide the student with a good understanding of steel structural behavior, and design philosophies for the design of various steel structural components and their connections. It also introduces the basic concepts of design of timber as a structural component.

Learning outcomes

Upon the successful completion of this course, the students will be able to:

1. Distinguish between different design approaches like Elastic, Plastic and Limit State Methods in steel structures design.
2. Design simple riveted, bolted and welded connections.
3. Design the tension members.
4. Design the struts, columns including built-up as well as laced and battened columns.
5. Design the beams and built-up beams including the plate girders with stiffeners.
6. Design the Beam–Column Connections.
7. Design the Column Bases.
8. Design the timber columns, beams and trusses.

Learning and teaching approach used

The concepts of the various design philosophies are introduced through lectures with examples and their application to real time structural designs. This will be is followed by the design of few typical steel structures and their elements. The students are encouraged to design various real time and practical structures on their own to consolidate their design approaches and methods through tutorials/assignments. The time allocated for these activities are given below.

Lectures : 3 hours/week

Tutorial : 1 hour/week

Assessment:

Continuous assessment - 30 marks (30%)

1. Assignment – 15 marks.
2. Mid Term Test- 15 marks.

Semester End Examination- 70 marks (70%)

Written examination (3 hours) – 70 marks.

Pre-requisites: Structural Mechanics

Subject matter:

1. **Introduction:** Advantages and disadvantages of structural steel. Properties of Structural Steel. Rolled steel sections. I.S. Specifications and codes. Types of loads. Design methods
2. **Simple Connections:** Simple Riveted, Bolted and Welded connections.
3. **Tension Members:** Types of tension members, Net and effective areas, Design of tension members, lug angles, splices and gusset plates.
4. **Compression Members:** Struts and Columns. Built up columns. Design criteria, laced and battened columns. Design of axially and eccentrically loaded columns. Encased columns.
5. **Beams:** Lateral stability of beams, Bending, bearing and shear stresses, web buckling and web crippling. Built-up sections, Design of laterally supported and unsupported beams. Plate Girders including stiffeners, connections and curtailment of flange plates**.**
6. **Eccentric Connections:** Beam-column connections. Riveted and welded shear connections. Moment resistant connections
7. **Column Bases & Footings:** Simple bases, gussetted base and column bases. Design of Foundation bolts, Gusset base and Grillage footing.
8. **Timber Structures:** Introduction, timber beams, timber columns and Joints.

Reading List:

1. Negi, L.S., (2006). *Design of Steel Structures*. New Delhi: Tata McGraw Hill Publishing Company Ltd.
2. Duggal, S.K., (2009). *Design of Steel Structures* (3rd ed.). New Delhi: Tata McGraw Hill Publishing Company Ltd.
3. Punmia, B.C., Jain, A.K. and Jain, A.K., (2006). *Comprehensive Design of Steel Structures.* New Delhi: Laxmi Publications (P) Ltd.
4. Dayaratnam, P., (2008). *Design of steel Structures*, (2nd ed.). New Delhi: S. Chand & Company Ltd.
5. Arya, A.S. and Ajmani J.L., (1996) *Design of steel Structures*, (5th ed.). Roorkee: Nem Chand & Brothers.
6. Chandra, R., (1992). *Design of steel Structures – Vol. I*, (10th ed.). New Delhi: Standard Book House.
7. Vazirani, V.N. and Ratwani, M.M., (1979). *Steel Structures and Timber Structures*. New Delhi: Khanna Publishers.
8. IS: 800- 1984, *Code of Practice for General Construction in Steel*. New Delhi: Bureau of Indian Standards
9. SP:6 (1) – 1964, *Hand Book for Structural Engineers (1. Structural Steel Sections).* New Delhi: Bureau of Indian Standards
10. IS: 883- 1994, *Design of Structural Timber in Building – Code of Practice*. (4th revision) New Delhi: Bureau of Indian Standards

Date : June 2011

Name of the Module	:	Hydrology
Module Code	:	EVE301
Semester	:	V
Credit Value	:	12
Module Leader	:	Ms. Chimi Wangmo
Module Tutor	:	Ms. Chimi Wangmo and Mr. Ugyen Dorji

General objectives or aims of the module:

This module aims to introduce the variation in the occurrence, movement, and distribution of water in the natural system.

Learning outcomes:

At the end of this 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. Assess the yield of groundwater
8. Recommend the appropriate flood control measures
9. Demonstrate flood routing

Learning and teaching approach used

Mostly by lecture, but students are expected to support the module by reading from some of the suggested texts. Lectures introduce concepts and provide a broad background; demonstrations are used to clarify particular points of detail or to illustrate concepts. Tests and worksheets are used to help students to monitor their own progress through the module.

Lectures	: 3 hours/wk
Tutorial	: 1 hour/wk

Assessment:

Continuous assessment - 30 marks (30%)

Assignment & Quiz- 10 marks.

Mid Term Exam - 10 marks.

Class Test - 10 marks.

Semester End Examination - 70 marks (70%)

Written examination (3 hours) Closed book - 70 marks.

Subject matter :

1. **Introduction:** Hydrologic cycle, Forms of precipitation, Scope of hydrology, Hydrological data, hydrologic equation.
2. **Precipitation**: Types of precipitation, measurement of precipitation-rain gauges, estimates of missing data and adjustment of records-Mean Aerial depth of precipitation, Arithmetic average method, Theissen polygon method, Isohyetal method, Optimum rain-gauge network design, Depth-Area-duration (DAD) curves,Hyetograph, Mass curve, Analysis of rainfall data -Correlation of rainfall records,Recurrence interval by California method, Hazen's method, Kimball's method-frequency of storm, Maximum Intensity-duration curve,Maximum-depth-duration curve, Moving averages curve, Design storm and Probable Maximum Precipitation(PMP).
3. **Water Losses**: Evaporation-Factors affecting evaporation, Dayton's law, Methods of estimating lake evaporation, Evaporation pans, Colorado sunken pan, Piche Evaporimeter, Measures to reduce lake evaporation, Soil evaporation, Lysimeter, Transpiration-Evapotranspiration-Blaney Criddle method, Evaporation index method, Penman's Equation, Factors affecting Evapotranspiration, Infiltration-Horton's curve, Methods of determining infiltration-Double-ring infiltrometer-Tube infiltrometer, Infiltration indices-φ index,W index, f_{ave} index-watershed leakage, Water Balance equation.
4. **Runoff:** Classification of streams, Isochrones,Factors affecting runoff, Estimation of runoff-empirical formulae, curves and tables,Infiltration method, Unit Hydrograph theory
5. **Hydrographs:** Components of a hydrograph, factors affecting hydrograph, s eparation of stream flow components, unit hydrograph- derivation of unit hydrograph, average unit hydrograph, satrix method, Bernard's distribution graph, instantaneous unit hydrograph, synthetic unit hydrograph, applications of unit hydrograph.
6. **Stream Gauging**: Methods of stream gauging-current meter gauging, rating of current meter, stage-discharge rating curve, selection of site for a stream gauging station.
7. **Ground water**: Aquifer, aquiclude, aquifuge and aquitard, confined and unconfined aquifers, storage coefficient, transmissibility, Dupuit's equations for confined and unconfined wells, assumptions, specific capacity, yield test, pumping test, recuperation test.
8. **Flood Estimation and Control**: Definition of flood, standard project flood (SPF)-maximum probable flood (MPF), probable maximum precipitation (PMP), design flood, estimation of peak flood- physical indications, empirical formulae and curves, rational method, unit

hydrograph method and glood frequency studies, risk, reliability and safety factor, methods of flood control-flood control by reservoirs, retarding basins, Levees, Soil conservation measures, flood plain zoning, flood control economics, flood forecasting and warning.

9. **Flood Routing**: Reservoir routing, modified pulse method,ISD method, stream flow routing, Muskingum method

Reading list

1. Bhattacharya, P.K. (1996). *Elements of applied hydrology*. New Delhi: Khanna Publishers.
2. Chow, V.T., Maidment, D.R., Mays, L.W (1988). *Applied Hydrology*. McGraw Hill.
3. Garg, S.K. (2005). *Hydrology and Water Resources Engineering*. New Delhi: Khanna Publishers.
4. Gupta, B.L. (n.d.). *Water Resource Engineering and Hydrology.*
5. Manning, J.C. (1996). *Applied Principles of Hydrology* (3rd ed). Prentice Hall.
6. Subramanya, K. (2008). *Engineering Hydrology* (3rd ed). New Delhi: Tata McGraw Hill.
7. Raghunath, H.M. (2006). *Hydrology*: *Principles, Analysis and Design*. New Delhi: New Age International Publishers.
8. Reddy, J.R. (2007). *A Textbook of Hydrology*. New Delhi: Laxmi Publications.
9. Todd, D.K. (2006). *Groundwater Hydrology* (2nd ed). New Delhi: Wiley India(P) Ltd.
10. Vedula, S. (2007). *Water Resource Systems*. New Delhi: Tata McGraw-Hill.

Date: June 2011

Semester VI

Name of the Module	:	Environmental Science
Module code	:	EVS301
Semester	**:**	VI
Credit Value	**:**	9
Module Leader	:	Mr Basant Pradhan
Module tutor	**:**	Mr Basant Pradhan, Mr Bharat Kumar Humagai

General objectives or aims of the module:
The module aims to develop understanding of the problems associated with environmental degradation resulting from human activities. It will provide students with the scientific principles, concepts, and methodologies required to understand the inter-relationships of the natural world, to identify and analyze environmental problems both natural and human-made, to evaluate the relative risks associated with these problems, and to examine alternative solutions for resolving and/or preventing them." Environmental science is interdisciplinary; it embraces a wide variety of topics from different areas of study including biology, chemistry, earth science, social sciences, and politics.

Learning outcomes:
At the end of this module the students are expected to be able to:

1. learn multidisciplinary nature of environment.
2. synthesize different types of natural resources and thus be able to play an active role in conservation of it.
3. analyze the impacts of environmental degradation on ecology and society.

4. investigate different kinds of problems related to environment pollution.
5. explain the impacts of toxicity of certain heavy metals like arsenic, cadmium, lead, mercury, chromium, copper, zinc on health of living beings and environment.
6. learn various kinds of disaster mitigation techniques.
7. know local regulations and governing policies on pollution and environment.

Learning and teaching approach used

Some of the topics will be lectured, while some will be taken up for discussion. Case studies and presentation will be integral part of the course. This will enable students to get a better understanding of the environmental problems facing us today.

Field Trips

Typically one field trip to the municipal sewage treatment plant.

Small-Group Activities

Problem solving, design projects, and Internet research are the basis for small-group activities, which provide the opportunity for brainstorming, application, and synthesis of material from lectures and reading assignments. The groups must also present their findings to the rest of the class.

Lectures : 3 hours per week

Assessment (Theory)

Continuous assessment: 30 marks (30%)

1. Mid Term Exam – 15 marks
2. Assignments & Case Studies – 15 marks

Semester End Examination: 70 marks (70%)

A closed book exam for 3 hours will be held at the end of the semester.

Subject Matter:

1. Multidisciplinary nature of environmental studies: Definition, scope and importance, man-environment relationship, environmental degradation

2. Ecology Elements of ecology, Ecological balance and consequences of change, Relevance of ecology to human affairs, man environment relationship, population dynamics, principles of the ecosystem's basic features of biochemical cycles and ecosystems, energy flow and trophic structure, limiting factors and tolerance levels, factors affecting ecosystems, food chains-examples, gross land ecosystem.

3. Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems; a) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, case studies. b) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. c) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, case studies. d) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. e) Forest resources: Forest as a resource, deforestation & associated problems. Role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles

4. Environmental Pollution: Definition, cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management: Causes, effects and control measures of urban and industrial wastes, Role of an

individual in prevention of pollution, Environmental ethics : Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Environmental problems related to industries like cement, food processing, ferroalloys, breweries, meat and poultry etc. and case studies

5. Hazardous Metals Arsenic, cadmium, lead, mercury, chromium, copper, zinc.

6. Regulations governing pollutant emissions: Bhutan environment and pollution regulations concerning water pollution, air pollution, solid wastes and hazardous waste emission standards

7. Introduction to disaster management: Floods, earthquake, cyclone, landslides and case studies

Reading list

1. Ambasht, R.S. (2008). *Environment & Pollution* (4th ed). New Delhi: CBS Publishers & Distributors
2. Benny, J. (2009). *Environmental Studies*. New Delhi: Tata Mcgraw Hill
3. Canter, L.W (1996). *Environmental Impact Assessment* (2nd ed). Singapore: Mcgraw Hill, Inc.
4. Masters, G. M. (1991). *Introduction to Environmental Engineering and Science.* New Delhi: Prentice-Hall of India Pvt. Ltd.,
5. Nebel, B. J. (1987). *Environmental Science*. New York: Prentice-Hall Inc.
6. Rao, M.N. & Rao, H.V.N. (1989). *Air Pollution*. New Delhi:Tata McGraw Hill, Inc.
7. Wanger, K.D. (1998). *Environmental Management*. Philadelphia: W.B. Saunders Co.,
8. Brunner, R.C. (1989). *Hazardous Waste Incineration*. New York: McGraw Hill, Inc.
9. Peavy, H. S., Rowe, D. R. & Tchobanoglous, G. (1987). *Environmental Engineering*. Singapore: McGraw Hill, Inc.
10. Eckenfelder Jr, W.W. (1989). *Industrial Water Pollution Control*. Singapore: McGraw Hill, Inc.
11. La Grega, M.D., Buckingham, P. L., & Evans, J.C. (1994). *Hazardous Waste Management*. New York: McGraw Hill International.
12. Vigil, S., Theisen, H., & Tchobanoglous, G. (1993). *Integrated Solid Waste Management*:*Engineering Principles and Management Issue.* Singapore: Mcgraw Hill, Inc.
13. Da Rosa, A.V. (2005). *Fundamentals of Renewable Energy Process.* New Delhi: CBS Publishers & Distributors
14. Tingey, D.T., & Barker, J.R. (1999). *Air Pollution Effects on Biodiversity*. New Delhi: CBS Publishers & Distributors.
15. Calow, P. (1998). *The Encyclopedia of Ecology & Environment Management*. New Delhi: CBS Publishers & Distributors
16. S.S.Dara (2009). *A Text Book of Engineering Chemistry.* New Delhi: S.Chand & Company Ltd
17. G. W. van Loon and S. J. Duffy, Environmental Chemistry, 2nd. ed., Oxford University Press, New York, 2005.
18. R. P. Turco, Earth Under Siege: From Air Pollution to Global Change, Second Edition, Oxford University Press, New York, 2002.

Date: June 2011

Name of the Module : Design of Concrete Structures-I
Module Code : DOS302
Semester : VI
Credit Value : 12

Module Leader : Mr. Ugyen Tenzey
Module Tutor : Mr. Ugyen Tenzey

General objectives or aims of the module:

The general objective of this course is intended to provide the student with a good understanding of reinforced concrete behavior and the necessary tools that are needed to design reinforced concrete members based on the limit states design philosophy.

Learning outcomes

Upon the successful completion of this course, the students will be able to:

1. Select the appropriate concrete and reinforcing steel grades based their behaviour with time and different loads.
2. Distinguish between different design philosophies like Working, Ultimate and Limit state methods of design.
3. Design the RCC beams using limit state method.
4. Design the RCC columns using limit state method.
5. Design the RCC slabs, lintels and staircases using limit state method.
6. Design the RCC beams and slabs for torsion.
7. Design the RCC isolated and combined footings.
8. Design the RCC retaining walls.

Learning and teaching approach used

The concepts of the various design philosophies are introduced through lectures with design examples and their application to real time structural designs. The students are encouraged to design various real time and practical reinforced concrete structural components on their own to consolidate their design approaches and methods through tutorials/assignments.

The time allocated for these activities are given below.

Lectures : 3 hours/week
Tutorial : 1 hour/week

Assessment:

Continuous assessment - 30 marks (30%)

1. Assignment – 15 marks.
2. Mid Term Test- 15 marks.

Semester End Examination - 70 marks (70%)

Written examination (3 hours duration) – 70 marks

Pre-requisites: CE 404 – Structural Mechanics.

Subject matter:

1. **Basic Material Properties:** Properties of Concrete - Compressive Strength, Tensile Strength, Stress-strain curve, Modulus of elasticity, Shrinkage, Creep, Characteristic strength, Grades of concrete, Design stress-strain curve. Properties of Reinforcing steel – Types and grades, Stress-strain curve, I.S. Specifications of concrete and reinforcing steel.
2. **Basic Design Philosophies:** Basic concept of reinforced concrete design, Working Stress**,** Ultimate Strength and Limit State Method of design**.**

3. **Analysis and Design of Sections in Bending:** Flexure of beams by working stress and limit state methods. Design of singly and doubly reinforced sections, T and L sections by limit state method. Detailing of beams.
4. **Shear, Bond and Torsion:** Behaviour of beams in Shear, Bond and Torsion. Design for shear. Anchorage and splicing of reinforcement. Detailing of reinforcement. Design of beams and slab for torsion.
5. **Serviceability Conditions:** Serviceability Limit states of Deflection and Cracking, calculation of long term and short term deflections.
6. **Compression Members:** Short and long columns. Eccentrically loaded columns. Code requirements. Design of short columns under Uniaxial and Biaxial loading.
7. **Slabs & Staircases:** Design of one way and two way slabs. Detailing of slabs. Circular slabs, yield line theory for slabs. Beam and slab construction. Introduction to flat slabs.
8. **Footings & Retaining Walls:** Types of footings, General design considerations and code requirements, design of isolated and combined column footings. Types of retaining walls, Design and detailing of cantilever and counter fort type of retaining walls.

Reading List:

1. Pillai, S.U. and Menon, D., (2007). *Reinforced Concrete Design* (3rd ed.). New Delhi: Tata McGraw Hill Publishing Company Ltd.
2. Raju, N.K. and Pranesh, R.N., (2006). *Reinforced Concrete Design*. New Delhi: New Age International (P) Ltd. Publishers.
3. Punmia, B.C., Jain, A.K. and Jain, A.K., (2008). *Reinforced concrete-limit state design.* New Delhi: Laxmi Publications (P) Ltd.
4. Sinha, S.N., (2005). *Reinforced Concrete Design.* New Delhi: Tata McGraw Hill Publishing Company Ltd.
5. Syal, I.C. and Goel, A.K., (2004). Reinforced Concrete Structures. New Delhi: S. Chand & Company Ltd.
6. Nilson, A.H. Darwin, D. and Dolan C., (2005). *Design of Concrete Structures*. New Delhi: Tata McGraw Hill Publishing Company Ltd.
7. Sinha, S.K., (2002). *Reinforced Concrete Design,* (2nd ed.) New Delhi: Tata McGraw Hill Publishing Company Ltd.
8. IS: 456-2000, *Plain and Reinforced Concrete – Code of Practice* (4th ed.) New Delhi: Bureau of Indian Standards.
9. SP-16 (1978). *Design Aids for reinforced Concrete to IS: 456-1978*, New Delhi: Bureau of Indian Standards.
10. SP-34 (1978). *Handbook on Concrete Reinforcement and Detailing*, New Delhi: Bureau of Indian Standards.

Date : June 2011

Name of the Module : Foundation Engineering
Code of the Module : FED302
Semester : VI
Credit value : 12
Module leader : Mr. Sabuar Rahman
Module Tutor : Mr. Sabuar Rahmanand Dr. Cheki Dorji

General objective:

To introduce the basic concepts and fundamentals in foundation engineering and its applications to civil engineering problems.

Learning outcomes:

Upon successful completion of this course the student will be able to:

1. Explain and compute earth pressures.
2. Design retaining walls.
3. Analyze the stability of slopes.
4. Select appropriate foundation for the field conditions
5. Design various types of foundation including machine foundations.
6. Explain the purpose of soil exploration and conduct different tests for soil exploration and their analysis of test data.
7. Explain different ground improvement technique required for different soil condition.

Learning and teaching approach used:

Lectures introduce basic concepts and demonstration of experiment. Practical examples are used to clarify particular points of detail or to illustrate concepts. Tutorial sessions develop problem solving skills and awareness of practical application of the subject material. Directed reading and assigned problems develop learning at a pace appropriate to the individual student. Tests and worksheets are used to help students to monitor their own progress in the module.

Lecture: 3 hrs/wk

Tutorial: 1 hr/wk

Practical: 2 hrs/wk

Assessment:

Theory

Continuous assessment - 25 marks (25%)

(i). Assignments :10 marks

(ii) Mid term test : 10 marks

(iii) Class test : 5 Marks

Semester End Examination: 50 marks (50%)

Written examination (3 hrs duration) – 50 marks

Practical:

Continuous assessment - 25 marks (25%)

(i) Evaluation of regular practical works: 15 marks

(ii) Internal Practical examination/ viva-voce: 10 Marks

Pre-requisite: FED301 Soil Mechanics

Subject matter:

Theory:

1. **Earth pressure and retaining structures:** Earth pressure at rest, Active and Passive earth pressure computation using Rankine's & Coulomb's earth pressure theories, Computation of active and passive earth pressure for c-φ soil by Bell's theory, Culmann's Graphical method of earth pressure, Stability analysis of retaining wall.

2. **Stability of slopes:** Embankment slopes—Road and earth dam embankments, Hill slopes, Modes of failure and usual protective measures. 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,
3. **Foundations:** Common types of foundations with examples, Illustration of situations where each one of them is adopted, Basis for design. **Shallow Foundations**- Types and their selection, Terminology. 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. Settlement:- Component of settlement, Limits of settlement, Estimation of settlement of footings on sand using penetration and load test data, Proportioning of footings.

   Pile Foundation:- Situations where adopted, Types of piles, Outlines of steps involved in proportioning, Bearing capacity and settlement of single and group of piles, proportioning with field/lab data as input. **Well foundations**: - Situations where adopted, Elements of wells, Types of wells, Methods of construction, Tilt and shift, Remedial measures, Proportioning- Depth and size of wells on the basis of scour depth, bearing capacity & settlement.
4. **Introduction to machine foundation:** Types of machines and their foundations, Terminology, Free and forced undamped vibration, Free and forced damped vibration, Design criteria, Field methods of determining design parameters—Cyclic plate load test, Block vibration test.
5. **Soil Exploration:** Purpose of soil exploration, Boring, Sampling, Standard penetration test, static and dynamic cone penetration tests, Co-relations between penetration resistance and shear strength parameters, plate load test. Planning of soil investigation, number of bore holes and depth of exploration, types of tests to suit soil conditions.
6. **Ground Improvement Techniques:** Physical and Chemical methods of ground improvement.

Practicals:

1. Consolidation test (full), Triaxial Test.
2. Demonstration of Plate load test.
3. Boring, Sampling for Soil Investigations.
4. Standard Penetration Test
5. Block vibration test.
6. Static and Dynamic cone tests.

Reading List:

1. Murthy. V.N.S. (2002). *Principles of soil mechanics and foundation engineering, (3rd ed.),* Delhi: UBS Publishers Distributors.
2. Punmia, B.C. (2009). *Soil mechanics & Foundation,* (4th ed.), Delhi: Laxmi Publication.
3. Murty, V. N. S. (2009). *Textbook of soil mechanics and foundation engineering: geotechnical engineering series,* (2nd ed.), *Delhi:* CBS Publishers.
4. Arora, K. R. (2009). *Soil mechanics and foundation engineering: geotechnical engineering. (3rd ed.),* Delhi: Standard Publishers.
5. Kazimi, S. M. A.(2003). *Soil mechanics.* (2nd ed.). Delhi: Tata McGraw Hill.
6. Kaniraj. S.R. (2008). *Design aids in soil mechanics and foundation engineering, (2nd ed.),* Delhi: Tata McGraw Hill.
7. Oza. H.P. (1969). *Soil mechanics and foundation engineering.* Delhi: Charotar Book Stall
8. Bharat. S. and Shamshor. P. (1976). *Soil mechanics and foundation engineering.* Roorkee: Nem Chand and Bros.
9. Gopal. R. and Rao, A . S . R. (2006). *Basic and applied soil mechanics*, (3rd ed.), Delhi: New Age International Publisher.

10. Mittal. S. (2008). *Soil Testing for Engineers.* Delhi: Khanna Publication.
11. Coduto. D.P. (2006). *Geotechnical engineering*, (2nd ed.), Delhi, Prentice-Hall.
12. Kramer. S. L. (2006), *Geotechnical earthquake engineering*, (2nd ed.), Delhi, Pearson Education.
13. Alam.S. (2004). *Modern geotechnical engineering,* (2nd ed.), Delhi: CBS Publishers.
14. Alam.S. (2004). *Basic soil mechanics and foundations.* Delhi: CBS Publishers.
15. Gulhati. S. K and Datta. M. (2006). *Geotechnical engineering*, (2nd ed.), Delhi, Tata McGraw Hill.
16. Holtz. R. & Kovacs. W.D. (1981). Introduction to Geotechnical Engineering, New York: John Wiley and Sons.
17. Lambe. T.W. and Whitman, R.V. (1969). Soil Mechanics. New York: John Wiley & Sons.
18. Terzaghi. K. & Peck. R.B. (1968). *Soil Mechanics in Engineering Practice*, New York: John Wiley and Sons.

Date: June 2011

Name of the Module : Environmental Engineering - I
Module Code : EVE302
Semester : VI
Credit Value **:** 12
Module Leader **:** Dr. Cheki Dorji
Module Tutor **:** Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:

To introduce the principles underlying the design of water treatment systems. It also offers insight in the design of plumbing system.

Learning outcomes:

At the end of this module the students will be able to.

a. Analyse inputs, outputs and functioning of urban water supply systems.
b. Estimate the design flows, design periods, and design population.
c. Assess yield and development of the source and intake works.
d. Investigate physical, chemical and biological quality parameters of potable water.
e. Determine the size of water treatment units.
f. Perform hydraulic analysis of distribution systems, pumping required for water supply systems.
g. Summarize various systems of plumbing.

Learning and teaching approach used:

Lectures introduce concepts and provide a broad background; demonstrations are used to clarify particular points of detail or to illustrate concepts. Tests and worksheets are used to help students to monitor their own progress in the module.

Lectures : 3 hours/wk

Tutorial : 1 hour/wk

Assessment:

Continuous assessment - 30 marks (30%)

1. Assignment - 10 marks.
2. Mid Term Exam -10 marks.
3. Class Test - 10 marks

Semester End Examination - 70 marks (70%)

Written examination - 70 marks. It will be a closed book test of 3 hours.

Pre-requisite: FMH201- Fluid Mechanics

Subject matter:

1. **General:** Importance of water, role of an environmental engineer, historical overview.
2. **Water Demand:** Design flows, design periods, and design population,factors affecting water consumption, variations in water demand, design capacities for various water supply components.
3. **Sources of water and Collection Works:** Alternative sources i.e. rain, surface and ground water, development of source and intake works.
4. **Quality of Water:** physical, chemical and biological water quality parameters, water quality requirements, and standards.
5. **Treatment of Water:** Historical overview of water treatment, water treatment processes, screening, settling operations, coagulation, softening, filtration, disinfection, other treatment processes: aeration, reverse osmosis, dissolved solids removal, treatment plant design, preparation of hydraulic profiles.
6. **Distribution of Water:** Requirements of good distribution system, layout of distribution networks, methods of distribution, system of supply, distribution reservoirs, types, storage capacity, design and hydraulic analysis of distribution systems, components, selection of pipe materials and joints, capacity and pressure requirements, pumping required for water supply systems.
7. **Plumbing Design:** General terms, house water connections, design consideration for water piping system in buildings, design principles, plumbing design for buildings.
8. **Planning and preparing water supply projects:** Data collection and analysis, project formulation, drawings and estimates, project reports.

Reading List:

1. Garg, S. K. (2005). *Water Supply Engineering: Environmental Engineering*, (4th ed.). Delhi: Khanna Publisher.
2. Metcalf & Eddy Inc. (2005). *Wastewater Engineering: Treatment and Reuse*. (4th ed.). Delhi: Tata McGraw Hill.
3. Hammer, M.J. (2006). *Water and Wastewater Technology*. (4th ed.). Delhi: Prentice Hall.
4. Peavy, H.S., Rowe, D.R., & Tchobanoglous, G. (1985). *Environmental Engineering.* Delhi: Tata McGraw Hill.
5. Viessman, W. and Hammer, M. J. (2005). *Water Supply and Pollution Control*. Delhi: Pearson Education.
6. Sawyer, C.N., McCarty, P.L. & Parkin, G.F. (1994). Chemistry for Environmental Engineering (4th ed.). New York: McGraw Hill.
7. Reynolds, T.D. & Richards, P.A. (1996). *Unit Operation and Processes in Environmental Engineering* (2nd ed.). Boston: PWS Publishing Company.

Date: June 2011

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Name of the Module : Design of Steel Structures-II
Module Code : DOS303
Semester : VI
Credit Value : 12
Module Leader : Mr. Ugyen Tenzey
Module Tutor : Mr. Ugyen Tenzey

General objectives or aims of the module:

The goal of this course is to study the various design approaches and procedures to arrive at the dimensions of components of various steel structures and their connections. The structures include industrial structures, bridges, water tanks and towers.

Learning outcomes

Upon the successful completion of this course, the students will be able to;

1. Design the moment resistant connections.
2. Design the industrial structures like steel framed buildings, gantry girders etc..
3. Design the bridges - plate girder bridges and truss bridges.
4. Design the steel water tanks.
5. Design the transmission towers.
6. Design the simple steel structural elements using plastic design method.

Learning and teaching approach used

The concepts of the design procedures for different steel structures are introduced through lectures with examples and their application to real time structural designs. This will be is followed by the design of few typical steel structures and their elements. The students are encouraged to design various real time and practical structures on their own to consolidate their design approaches and methods through tutorials/assignments.

The time allocated for these activities are given below.

Lectures : 3 hours/week
Tutorial : 1 hour/week

Assessment:

Continuous assessment - 30 marks (30%)

1. Assignment – 15 marks.
2. Mid term Test- 15 marks.

Semester End Examination - 70 marks (70%)

Written examination(3 hours duration) – 70 marks

Pre-requisites: Structural Mechanics and Design of steel and Timber Structures-I.

Subject matter:

1. **Industrial Buildings:** Elements of Industrial buildings, general arrangement and stability considerations, Design of purlins, roof trusses, industrial building frames, gantry girder and bracings.

2. **Bridge:** Typesn of bridges. Plate girder and truss bridges, General arrangement, Design loads for highway bridges, Design procedure for bridges.
3. **Water Tanks:** Types and design guidelines, Rectangular and Cylindrical Tanks, Staging for Water Tanks.
4. **Towers:** Transmission line towers, Microwave towers, Design loads, Classification, design procedure and specification.
5. **Elementary Plastic Analysis and Design:** Concepts of Plastic Design and its application for the design of simple beams and frames.

Reading List:

11. Negi, L.S., (2006). *Design of Steel Structures*. New Delhi: Tata McGraw Hill Publishing Company Ltd.
12. Duggal, S.K., (2009). *Design of Steel Structures* (3rd ed.). New Delhi: Tata McGraw Hill Publishing Company Ltd.
13. Punmia, B.C., Jain, A.K. and Jain, A.K., (2006). *Comprehensive Design of Steel Structures.* New Delhi: Laxmi Publications (P) Ltd.
14. Dayaratnam, P., (2008). *Design of steel Structures*, (2nd ed.). New Delhi: S. Chand & Company Ltd.
15. Arya, A.S. and Ajmani J.L., (1996) *Design of steel Structures*, (5th ed.). Roorkee: Nem Chand & Brothers.
16. Chandra, R., (1992). *Design of steel Structures – Vol. II*, (10th ed.). New Delhi: Standard Book House.
17. Vazirani, V.N. and Ratwani, M.M., (1979). *Steel Structures and Timber Structures*. New Delhi: Khanna Publishers.
18. IS: 800- 1984, *Code of Practice for General Construction in Steel*. New Delhi: Bureau of Indian Standards
19. SP:6 (1) – 1964, *Hand Book for Structural Engineers (1. Structural Steel Sections).* New Delhi: Bureau of Indian Standards
20. IS: 883- 1994, *Design of Structural Timber in Building – Code of Practice*. (4th revision) New Delhi: Bureau of Indian Standards

Date: June 2011

Semester VII

Name of the Module : Design of Concrete Structures-II
Module Code : DOS401
Semester : VII
Credit Value : 12
Module Leader : Mr. Ugyen Tenzey
Module Tutor : Mr. Ugyen Tenzey

General objectives or aims of the module:

This course is to provide the student with a good understanding of reinforced concrete behavior and the necessary tools that are needed to design reinforced concrete members based on the limit states design philosophy. It is also to briefly introduce the concept of prestressed concrete and its design methodologies. The module also will introduce some basics concepts in the design of reinforced concrete bridges and culverts and water tanks.

Learning outcomes

Upon the successful completion of this course, the students will be able to:

1. Explain the different methods of prestressing systems used in prestressed concrete.
2. Explain the design philosophy of prestressed concrete elements and losses of prestress.
3. Design of prestressed concrete beams using limit state method.
4. Design the R.C.C. continuous and curved beams using limit state method.
5. Explain the effects of shrinkage and creep of concrete on R.C.C. elements.
6. Analyse and design the R.C.C. building frames using limit state method.
7. Design the R.C.C. water tanks including their foundations.
8. Design the R.C.C. culverts and main components of bridges for various IRC loadings.

Learning and teaching approach used

The concepts of the various design philosophies are introduced through lectures with examples and their application to real time structural designs. This will be is followed by the design of few typical PSC and RCC structures and their components. The students are encouraged to design various real time and practical structures on their own to consolidate their design approaches and methods through tutorials/assignments.

The time allocated for these activities are given below.

Lectures : 3 hours/week

Tutorial : 1 hour/week

Assessment:

Continuous assessment - 30 marks (30%)

1. Assignment – 15 marks
2. Mid term Test- 15 marks

Semester End Examination - 70 marks (70%)

Written examination (3 hours duration) – 70 marks

Pre-requisites: Structural Mechanics and Design of Concrete Structures -I.

Subject matter:

1. **Prestressed Concrete:** Introduction to basic concepts and the prestressing systems, material properties, losses of prestress. Merits and demerits of prestressed concrete. I.S. Specifications (IS:1343-1980), analysis and design of sections for flexure and shear. Procedure for limit state design and introduction to design of continuous beams.
2. **Continuous and Curved Beams:** Design of continuous reinforced concrete beams, moment redistribution, beams curved in plan.
3. **Shrinkage and Creep:** Effect of shrinkage and creep on stresses in R.C columns and beams.

4. **Building Frames:** IS specification and loading standards on building frames, Analysis for vertical loads, analysis of frames subjected to horizontal forcers using approximate methods (portal and cantilever methods). Ductile detailing.
5. **Water Tanks:** Introduction, design of rectangular and circular water tanks. Concepts and design of underground tanks. Introduction of basic concepts of staging and foundations of water tanks. Basic design features of Intze tanks.
6. **Culverts and Bridges:** Types of bridges, I.R.C. loadings and basic concepts of bridge design, Design of slab culvert, design of deck slab, longitudinal girders and cross girders for bridges. Introduction to design of T-beam bridges.

Reading List:

1. Pillai, S.U. and Menon, D., (2007). *Reinforced Concrete Design* (3rd ed.). New Delhi: Tata McGraw Hill Publishing Company Ltd.
2. Raju, N.K., (2007). *Prestressed Concrete*, (4th ed.). New Delhi: Tata McGraw Hill Publishing Company Ltd.
3. Lin, T.Y. and Burns, N.H., (2004). *Design of Prestressed Concrete Structures* (3rd ed.). Singapore: John Wiley & Sons (Asia)
4. Punmia, B.C., Jain, A.K. and Jain, A.K., (2006). *R.C.C Designs (Reinforced Concrete Structures).* New Delhi: Laxmi Publications (P) Ltd.
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. Sinha, N.C. and Roy, S.K., (2007). *Fundamentals of Reinforced Concrete* (7th ed.). New Delhi: S. Chand & Company Ltd.
7. Syal, I.C. and Goel, A.K., (2004). *Reinforced Concrete Structures* (6th ed.). New Delhi: S. Chand & Company Ltd.
8. Nilson, A.H. Darwin, D. and Dolan C.W., (2008). *Design of Concrete Structures*. New Delhi: Tata McGraw Hill Publishing Company Ltd.
9. Victor, D.J., (2001). Essentials of Bridge Engineering (4th ed.). New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.
10. Rakshit, K.S., (2004). Design and Construction of Highway Bridges. Kolkata: New Central Book Agency (P) Ltd.
11. Ponnuswamy, S., (2008). *Bridge Engineering*. New Delhi: Tata McGraw Hill Publishing Company Ltd.
12. IS: 456-2000, *Plain and Reinforced Concrete – Code of Practice (4th ed.).* New Delhi: Bureau of Indian Standards.
13. IS: 875-1987, *Code of Practice for Design Loads (Other than Earthquakes) for Buildings and Structures*. New Delhi: Bureau of Indian Standards.
14. IS: 1343-1980, *Code of Practice for Prestressed Concrete*. New Delhi: Bureau of Indian Standards.
15. IS: 3370-1965, *Code of Practice for Concrete Structures for the Storage of Liquids.* New Delhi: Bureau of Indian Standards.
16. SP-34: 1987, *Handbook on Concrete Reinforcement and Detailing.* New Delhi: Bureau of Indian Standards.
17. IRC: 5-1998, *Standard Specifications and Code of Practice for Road Bridges, Section :I, General Features of Design (4th revision).* New Delhi: Indian Road Congress.
18. IRC: 6-2000, *Standard Specifications and Code of Practice for Road Bridges, Section :II, Loads and Stresses (4th revision).* New Delhi: Indian Road Congress.
19. IRC: 21-2000, *Standard Specifications and Code of Practice for Road Bridges, Section :III, Cement Concrete – Plain and Reinforced (3th revision).* New Delhi: Indian Road Congress.

Date: June 2011

Name of the Module : Environmental Engineering - II
Module Code : EVE401
Semester : VII
Credit Value : 12
Module Leader : Ms. Chimi Wangmo
Module Tutor : Ms. Chimi Wangmo and Dr. Cheki Dorji

General objectives or aims of the module:

To introduce students to the principles underlying the design of wastewater treatment systems. It also offers insight in the management of industrial and solid waste.

Learning outcomes:

At the end of this module the students will be able to

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. Determine the size of wastewater treatment systems for preliminary, primary and secondary treatment.
5. Identify different methods of disposal of sewage.
6. Appraise the significance of separate treatment of industrial waste.
7. Determine types of solid waste and procedures adopted for their disposal.

Learning and teaching approach used

Lectures introduce concepts and provide a broad background; demonstrations are used to clarify particular points of detail or to illustrate concepts. Tests and worksheets are used to help students to monitor their own progress in the module. The students are expected to support the module by reading from some of the suggested texts.

Lectures : 3 hours/wk

Tutorial : 1 hour/wk

Practicals : 2 hours/wk

Assessment:

Continuous assessment - 50 marks (50%)

Theory - 25 marks (25%)

1. Assignment - 5 marks.
2. Mid Term Exam - 10 marks.
3. Class Test -10 marks

Practicals - 25 marks (25%)

1. Regular evaluation of experiments conducted during the practical classes - 15 marks
2. Internal practical exam with viva-voce -10 marks

Semester End Examination- 50 marks (50%)

Written examination (3 hours) - 50 marks.

Pre-requisite EVE302 – Environmental Engineering - I

Subject matter :

1. **General:** Systems of Sanitation, types of sewage and sewerage system, component of sewerage system, role of an Environmental Engineer, historical overview.
2. **Sewage Characteristics:** Physical, chemical and bacteriological characteristic and their testing, sampling, standards.
3. **Collection of Sewage:** quantity of sewage and variations, quantity of storm water- rational methods, shapes of sewer, hydraulic design of sewers, construction of and testing of sewer lines, sewer materials, joints and appurtenances, sewage pumping and pumping stations, maintenance of sewerage system.
4. **Treatment of sewage**: Classification of treatment processes, various treatment units- their purposes, sequences and efficiencies-screening, grit removal, oil and grease removal, sedimentation, sedimentation with coagulation, biological filtration, activated sludge process, oxidation pond, septic tank, Imhoff tank, soakage systems, digestion and disposal of primary and secondary sludge, recent trends in sewage treatment, nutrient removal.
5. **Wastewater Disposal and Reuse:** Disposal of sewage by dilution, standards of dilution for discharge of waste water into rivers, self-purification of streams, disposal on land – irrigation, quality standards for waste water effluents to be discharges on land, waste waters reuse.
6. **Plumbing and House drainage:** General principles, functions and types of traps, systems of plumbing, testing of house sewers, sanitary fittings, special plumbing requirements for hospitals; theatres, hotels, industries.
7. **Industrial waste treatment:** Introduction, significance, and case studies.
8. **Solid Waste Management:** Types of solid wastes and their collection and disposal methods.

Practiclas:

1. **Physical Parameters:**
   i. Determination of pH, Colour, Turbidity, Conductivity & Total Solids of water sample.

2. **Chemical Characteristics:**
   i. Determination of Acidity & Alkalinity of water sample
   ii. Determination of Total Hardness of water sample
   iii. Determination of Biochemical Oxygen Demand of water & waste water sample
   iv. Determination of Chemical Oxygen Demand (COD) of water & waste water sample
   v. Determination of Chlorides in water & waste water sample
   vi. Determination of Chlorine demand,
   vii. Determination of Optimum alum dose(coagulant)
   viii. Determination of Sulphate in water & waste water sample
   ix. Determination of Nitrate in water & waste water sample
   x. Determination of Phosphate in water & waste water sample

3. **Bacteriological Parameters:**
   i. Assessment of Biological MPN, Total Count, Membrane Filter Techniques.

Reading List:

1. Garg, S. K. (2005). *Water Supply Engineering: Environmental Engineering Vol-II*, (4th ed.). Delhi: Khanna Publisher.
2. Metcalf & Eddy Inc. (2005). *Wastewater Engineering: Treatment and Reuse*. (4th ed.). Delhi: Tata McGraw Hill.
3. Hammer, M.J. (2006). *Water and Wastewater Technology*. (4th ed.). Delhi: Prentice Hall.
4. Peavy, H.S., Rowe, D.R., & Tchobanoglous, G. (1985). *Environmental Engineering.* Delhi: Tata McGraw Hill.
5. Viessman, W. and Hammer, M. J. (2005). *Water Supply and Pollution Control*. Delhi: Pearson Education.
6. Sawyer, C.N., McCarty, P.L. & Parkin, G.F. (1994). Chemistry for Environmental Engineering (4th ed.). New York: McGraw Hill.
7. Reynolds, T.D. & Richards, P.A. (1996). *Unit Operation and Processes in Environmental Engineering* (2nd ed.). Boston: PWS Publishing Company.
8. Nathanson, J.A. (2006). *Basic environmental technology / water supply, waste management, and pollution control.* Delhi: Prentice-Hall.
9. Hosetti, B.B. (2006). *Prospects and Prospective of Solid Waste Management. Delhi:* New Age International.
9. Tchobanoglous. G., Theisen, H. & Vigil, S. (1993). Integrated *Solid Waste Management: Engineering Principles and Management Issues*, San Francisco: McGraw-Hill.

Date: June 2010

Name of the Module	: Irrigation Engineering
Module Code	: EVE402
Semester	: VI
Credit Value	: 9
Module Leader	: Mr. Ugyen Dorji
Module Tutor	: Mr. Ugyen Dorji and Ms. Chimi Wangmo

General objectives or aim of the module:

Develop ability of the students to understand concepts, principles and applications of Irrigation Engineering.

Learning outcomes:

Upon successful completion of this course the students will be able to:

1. Understand the quality requirement of irrigation water.
2. Select suitable system and method of irrigation.
3. Assess water requirements.
4. Predict the causes of water logging and their preventive measure.
5. Design irrigation channels.
6. Interpret the irrigation policies of Bhutan.

Learning and teaching approach used:

Lectures are used as the basic method of introducing new concepts and material. Problem sheets give essential practice in applying the new knowledge to analytical and design examples.

Lectures: 3 hrs/week.

Assessment:

Continuous assessment - 30 marks (30%)

1. Assignment - 10 marks.
2. Mid term Test - 10 marks.
3. Class Test - 10 marks.

Semester End Examination - 70 marks (70%)

Written examination (3 hours, closed book) - 70 marks.

Pre-requisite: Soil Mechanics & Fluid mechanics.

Subject matter:

1. **Introduction:** Definitions, functions, advantages, disadvantages of irrigation, present status of irrigation in Bhutan, Principal Crops and Crop Seasons.
2. **Water Requirements of Crops:** Irrigation water quality, crop period, duty, delta of a crop, irrigation efficiencies, consumptive use of water-consumptive irrigation requirement, net irrigation requirement, soil-moisture-irrigation relationship, estimating depth and frequency of irrigation on the basis of soil-moisture regime concept
3. **Irrigation System & methods:** Types of irrigation system, techniques of water distribution in farms.
4. **Hydraulics of Alluvial Rivers:** Sediment lo**ad,** bed formati**on,** mechanics of sediment transport- critical tractive force, regimes of flow, different stages of rivers, meandering, aggrading and degrading rivers, river training & bank protection works.
5. **Canal Irrigation:** Types of canals, canal alignment, parts of a canal irrigation system, , assessment of water requirements, estimation of channel losses, design of channels- regime and semi-theoretical approaches-Shield's Entrainment method, Kennedy's Theory, Lacey's Theory, silt control in canals.
6. **Distribution of Canal water:** Systems of regulation and control- intensive & extensive irrigation (warabandi), outlets- types, essential requirements, flexibility, proportionality, sensitivity, sensitiveness & efficiency, assessment of canal revenue.
7. **Water Logging:** Causes, preventive and curative measures, drainage of irrigated lands, saline and alkaline lands, types of channel linings and design of lined channel.
8. **Theories of Seepage:** Seepage force and exit gradient, salient features of Bligh's creep theory, Lane's weighted theory and Khosla's theory, Determination of uplift Pressures and floor thickness.
9. **Irrigation policies:** Irrigation policies of Bhutan.

Reading List:

1. Asawa, G.L. (1996). *Irrigation Engineering* (2nd ed). New Delhi: New Age International Publishers 1996.
2. Garg ,S.K. (2008). *Irrigation Engineering &Hydraulic structures* (22nd ed). Delhi: Khanna Publishers.
3. Modi, P.N. (1994). *Irrigation water Resources and Water Power Engineering*. Delhi: Standard Books Company.

4. National Irrigation Policy, Procedural Manual, RGOB.
5. Punmia, B.C., & Pande B.B.L. (1990). *Irrigation and waterpower engineering* (11th ed) Standard Publisher distribution.
6. Sahasrabudhe, S.R. (1985). *Irrigation Engineering and Hydraulic Structures (Including Hydrology& water power)* (5th ed). Ludhiana: Katson Publishing House.
7. Sharma, R.K., & Sharma T.K. (2002). *Irrigation Engineering* (1st ed). Delhi: S. Chand & company Ltd.
8. Sharma, S. K. (1998). *Design of Irrigation Structures* (1st ed). Delhi: S Chand & Company.
9. Singh, B. (1983). *Fundamentals of Irrigation Engineering* (7th ed). Roorke: Nem Chand & Bros.
10. Singh, G. (1980). *Irrigation Engineering*"(1st ed). Delhi: Standard Book House.
11. Varshney, R.S., Gupta, S.C., & Gupta, R.L.(n.d). *Theory and Design of Irrigation structures.* Roorkee: Nem Chand & Bros.

Date: June 2011

Name of the Module : Highway Engineering
Module Code : HWE401
Semester : VII
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:
To introduce the principles and philosophies of Highway planning, design and construction.

Learning outcomes:
Upon successful completion of this module, the students will be able to;

1. Explain the importance of highway.
2. Plan a highway network.
3. Decide the highway alignment for the given field conditions.
4. Design various geometric features of a highway.
5. Conduct traffic surveys for transportation planning.
6. Conduct the various test on highway materials for their suitability.

Learning and teaching approach used
Lectures and tutorials introduce concepts and philosophies of highway planning, design and construction with their application to real time problems.

Lectures : 3 hrs/wk
Tutorial : 1 hr/wk
Practicals : 2 hrs/wk.

Assessment:

Continuous assessment – 50 marks (50%)

Thoery – 25 marks (25%)

1. Mid term exam - 10 marks.
2. Assignment - 5 Marks.
3. ClassTests - 10 Marks

Practicals – 25 marks (25%)

1. Evaluation of experiments performed during practical class – 15 marks
2. Internal Examination/ Viva Voce – 10 marks

Semester End Examination - 50 Marks (50%)

Written examination (3 Hours) – 50 marks

Pre-requisite: Principles of Surveying –I and II

Subject matter:

1. **Introduction:** History of roads in Bhutan, highway development policies of Bhutan.
2. **Highway Network Planning:** Importance of highway, special characteristics, types of highway, necessity of highway planning, network patterns, planning surveys, preparation of plans, interpretation of planning survey, highway traffic forecasting, Time series Models, Prediction of Inter regional Traffic through average growth factor method, Elasticity method, Master plan preparation, Evaluation by Saturation method.
3. **Highway Alignment and Geometric Design:** Principles of highway alignment, alignment surveys, cross section elements: Lanes, camber, shoulders, medians, road margins, right of way, Cross section of roads in Urban areas: foot paths, mule tracks, bus bay location, Horizontal elements- sight distance, super elevation, transition curves; Vertical alignment-gradients vertical curves, design of intersections., At grade intersections-Rotary Intersections.
4. **Highway Materials:** Types of highway materials, properties and testing of aggregate and bitumen, design of bituminous mixes by marshal stability method.
5. **Pavement Materials:** Types of pavements, factors affecting pavement; design: CBR method, Westergards analysis, IRC method of Flexible and Rigid pavement Design.
6. **Highway Construction and Maintenance:** Types of highway construction, methods, choice, general principles, EFRC construction Techniques, specifications for the construction of Earth, WBM, Bituminous and cement concrete roads. Treatment for surface and surface drainage special equipment for road building. Type of pavement distress, maintenance methods, evaluation and overlays, roadside trees. Hill road construction and maintenance based on environmental friendly approach.
7. **Traffic Engineering Principles:** Components of Traffic Stream-Volume, speed and density, measurement and analysis, their relationships, Design Hourly volume, concept of EPCU, service volume, Level of service concept and application to highway design.
8. **Traffic Management and Control:** Traffic Control device, description of signs, markings and signals, Management principles- One-Way streets, parking management principles: One-Way streets, Parking management. Accidents: Recording and Analysis using IRC forms, analysis of individual accidents, Speed breakers, M.V Act, Traffic signals.
9. **Economic Evaluation of Transport Projects:** Need, Costs and benefits of transport projects, methods of economic evaluation - benefit-cost ratio method, first rate of return method, net present value method and internal rate of return method.

List of Experiments:

At least a minimum of 12 experiments have to be conducted;

1. **Test on Aggregate:** Aggregate suitability evaluation through the following tests – attrition, abrasion, impact, crushing, Sp. Gravity, Water absorption & shape tests.

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.
4. **AC Mix Design:** Mix design, Marshall stability method.
5. **Exercises on traffic Engineering:** Traffic volume and speed studies.
6. **Pavement condition studies:** Visual Methods and pavement evaluation using benkleman beam method.
7. **Demonstration of the Following Equipment:** Bump Integrator; Road Unevenness indicator; Skid Resistance Apparatus; Driver reaction and vision screening; Vehicle exhaust Pollution measurement- Lux meter, Noise meter, Alcohol Meter; Traffic Counters and weight in motion.

Reading list:

1. Khanna, S.K., & Justo C.E.G. (2001). *Highway Engineering (8th ed.)*. Roorkee: Nemchand Bros.
2. Wright, Paul H. (2010). *Highway Engineering*. Delhi: John Wiley & Sons.
3. Vaswani, N. K. (1977). *Highway Engineering.* Delhi: Roorkee Publishing House.
4. Khanna, S.K., & Justo C.E.G. (1994). *Highway Material Testing*. Roorkee: Nemchand Bros.
5. Kadiyali, L. R. (2007). *Traffic Engineering and Transportation Planning.* Delhi: Khanna Publishers.
6. Papacosta, C.S. (n.d). *Fundamentals of Transportation Engineering*. Delhi: Prentice Hall.
7. John K.C. (n.d).*Transportation Engineering- An Introduction*. New Jersey: Prentice Hall.

Date : June 2011

Name of the Module : Estimating and Costing
Module Code : BPD401
Semester : VII
Credit Value : 12
Module Leader : Mr. Tshering Tobgyel
Module Tutor : Mr. Tshering Tobgyel, Mr. Ugyen Dorji

General Objective or Aim of the Module:

The aim of this module is to introduce the principles and concepts of estimating (labour and material) and analysing the rate of various building materials conforming to their specifications as per given structural drawings.

Learning Outcomes:

Upon successful completion of this module, the students will be able to:

1. Perform different methods of building estimate.
2. Compute the quantities of various materials required for the engineering structures.
3. Analyze the rates of the material and manpower as per latest SQCA Specifications for Building & Road Works.
4. Write the specifications of the materials and construction methods.
5. Determine the value of the existing structures.

6. Prepare the tender documents as per latest CDB Manual and Financial Manual.

Learning and Teaching Approach:

Lectures : 3 hrs/wk
Tutorial : 1 hr/wk

Assessment:

Continuous Assessment – 30 marks (30%)

1. Mid Term Exam: 10 marks.
2. Assignment: 10 Marks.
3. Class Test/Project: 10 Marks

Semester End Examination – 70 marks (70%)

Written Examination (3hrs duration) – 70 marks

Subject Matter:

1. **Quantity Estimation:** Principles of estimation – Methods and units – Estimation of materials in building, roads, and any other prominent structures.
2. **Rate Analysis:** Analysis of rates for building, roads, and other prominent structures as per current practice of Bhutan Schedule of Rates.
3. **Principles of Specification:** Principle of general specifications of buildings and other prominent structures – Detailed specification of various building works, maintenance works and other prominent structures based on SQCA specification.
4. **Tendering and Documentation:** Tenders and type of tenders, Contracts and type of contracts , Award of contract, Legal problem in contract, Arbitrator and role of arbitrator in civil related works based on standard practices in Bhutan.
5. **Valuation:** Valuation of real properties (buildings etc.)

Reading Lists:

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 Dutta, B.N., (2004). *Estimating and Costing in Civil Engineering – Theory and Practice Including Specifications and Valuation*, Delhi: UBS Publishers.

4 Rangwala, S.C., (2001). *Estimating, Costing and Tendering [Professional Practice]*, Delhi: Charotar Publishing House.

5 Khanna, P.N., (2001). *Indian Practical Civil Engineers' Handbook – the standard ever-day reference book for all engineers & architects*, Delhi: Engineers' Publishers.

6 Patil, B.S., (2006). *Civil Engineering Contracts and Estimates*, (3rd ed.), Universities Press.

7 Goyal, S.C. and Jain, O.P., (2001). *Manual Estimating*, Roorkee: Nem Chand & Bros.

8 Hoelscher, R.P. and Springer, C.H., (2002). *Engineering Drawing & Geometry*, London: John Wiley & Sons Inc.

9 Ministry of Finance, (2001). *Financial Manual*.

10 Ministry of Finace, (2009). *Procurement Rules and Regulations*.

11 SQCA, (2009). *Specifications for Building & Road Works, Bhutan Schedule of Rates, Labour & Material Coefficient (Civil).*

12 CDB, (2009). Registration Manual.

Date: June 2011

Name of Module : Seminars
Module Code : SEM401
Semester : VII
Credit value : 6
Module Leader : Dr Cheki Dorji
Module Tutor : Dr, Cheki Dorji and Ms. Chimi Wangmo

General objectives:
To acquaint the student with aspects of Civil Engineering that are not normally encountered in classes and to prepare the technical reports and presentations.

Learning outcomes:
At the end of this module, students are expected to be able to:

1. read critically technical/research papers
2. discuss the topic which one has read in the papers
3. building one's own idea upon such papers
4. expand knowledge on the technical/research topics by searching and reading the relating information around them
5. write quality technical papers
6. have some idea of the state-of-the-art research being carried out in the electrical engineering discipline
7. Offer clear and well-structured oral presentations on a technical/research topic to seminar discussion in a group and produce clearly argued and coherently structured essays.

Learning and teaching approach used:
A student has to read, understand, and present technical/research papers related to their field of study. Student can propose their own topic and get it approved by the faculty members. Each student will make maximum 10 minutes presentation. Submit a well-structured report.

Assessment:

- **Continuous Assessment - 100 marks**

The detail marking scheme for each paper is in Table 1.0

Table 1.0: Marking scheme for seminar paper

	Area of Evaluation	Marks
1	Report	60
	i. Understandings of the contents of the papers and	10
	ii. Technical Writing Style: Clear, focused, and concise descriptions with effective use of mathematical or graphical representation	10
	iii. Summary of the ideas in the papers	6
	iii. Structure (abstract, introduction, description, discussion, conclusion, & references)	4
	iv. Logical argument and any supporting data/information to support the argument	20
	v. Originality in expanding and building upon the ideas in the papers	10
2	Presentation	40
	i. Structure of presentation (Introduction, summary of papers, arguments, conclusions, reference)	4
	ii. Clear understanding and explanation on the essence of the papers	6
	iii. Clear and logical arguments supported by good use of additional data, and information	10
	vi. Effective communication of the points of one's argument	10
	v. Use of Presentation Aids (PC/Projector. OHP, White Board, Handouts, Video, etc.)	4
	vi. Posture, Eye-contact, Voice, Language, Confidence	6
	Total Marks	100

Students must obtain 40% each in presentation and report writing. The overall pass mark for the module is 50%.

Date: June 2011

Name of the Module : Project
Module Code : PRW401
Semester : VII
Credit Value : 0
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:
To familiarize students with the literature survey and the process of defining a problem for the project work**.**

Learning outcomes:
Upon successful completion of this course the student will be able to

1. Formulate the problem for the specific project of his interest.
2. Analyse the technical and economic implications of the proposed project.

Learning and teaching approach used

Directed independent reading and assigned problems to develop inquisitiveness for bridging the current research loopholes into the limelight 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.

Directed learning : 4 hours/wk

Assessment: A Unified assessment for the project will be done at the end of eighth Semester

Pre-requisite: All the Engineering Courses till Pre final year.

Subject matter: This will depend upon student's interest, availability of guides and the Guide's expertise.

Reading list:

Current research topics from research journals and magazines.

Date: June 2011

Semester VIII

Name of the Module	:	Management
Module Code	:	MGT401
Semester	:	VIII
Credit Value	:	12
Module Leader	:	Mr. Nima Dukpa
Module Tutor	:	Mr. Nima Dukpa and Mr Ugyen Dorji

General objective of the module:

This foundation course on management for the engineering students is designed to develop basic understanding of the general management functions, techniques of construction project management as well as the social and ethical responsibilities that they will be engaged in the management of various public and private sector organizations.

Learning outcomes:

Upon successful completion of this module, students would:

1. Have developed their critical thinking skills in relation to principles and theories of management.
2. Be able to apply the fundamental principles of management and exercise social and ethical responsibilities.
3. Be able to apply the Project management principles and practices.
4. Have developed the ability to function effectively as a project manager.
5. Have developed the ability to function effectively on a project team.
6. Have developed the ability to communicate effectively.

Learning and teaching approach:

- Lecture : 3 hours per week
- Tutorial : 1 hour per week

Assessment:

Continuous Assessment - 30 marks (30%)

1. Assignment - 5marks
2. Term Test - 10marks
3. Group Projects - 15marks

Semester End Examination - 70marks (70%)

3 hrs written examination (closed book)

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-requisite: Entrepreneurship development

Subject matter:

Part A: General Management

1. Introduction to Management: The evolution of management thought; contributions from F.W. Taylor and Henri Fayol; Definition of management; The functions of management; The (Mintzberg's) managerial roles; The managerial skills; Environmental constraints on managers; Responding to change; Ethical behavior in management; How managers can become more responsive to social issues and needs.

2. Planning: The basics of Planning, Types of plans; steps in planning, Barriers to effective planning; Commitment to the Planning Process. Management by objectives; The process of developing strategic plan.

3. Organizing: The decision making process; Process of organizing; Organizational Structure; Authority and Responsibility; Delegation and Empowerment; Centralization and Decentralization; Organizational culture and its impact.

4. Leadership and Communication: Leadership and its role; Leadership style; Leadership development; Leadership behavior; Motivating & Rewarding Employees; Extrinsic rewards and intrinsic rewards; Managing work teams; Communication process and skills; Interpersonal Skills; morale building.

5. Controlling: The purpose of controlling; Monitoring and Controlling processes.

6. Inventory Management: The inventory Objectives and functions; types of inventory; Dependent and Independent Demand; Materials management and Inventory control; Fundamental inventory model.

Part B: Project Management

7. Project framework and integration management: Key principles for PM success, Defining project and project management, Project manager’s Roles and responsibilities, Project constraints, Project life cycle, Ethical standards and code of professional conduct.

8. Project scope management: Statement/scope of work; Work breakdown structure; Scope Verification and Control.

9. Stakeholder and Communication Management: Stakeholder Analysis; Stakeholder Planning; Communication plan and techniques; Information distribution; Performance reporting.

10. Project time and cost management: Define project tasks/activities; Estimate time; Determine task dependences; Determine task constraints; Create work breakdown structure; Develop schedule (create Gantt chart and Network diagrams); Allocate resources and Schedule control; Estimate costs and determine budget; Control costs, Perform earn value analysis.

11. Managing Project Risk: Risk identification; Risk response plan; Risk monitoring and control.

12. Managing and monitoring the project schedule: Update project plan and schedules; Status meetings and reports; Dealing with issues; Manage project team.

13. Managing Scope: Define scope; Process for managing scope changes; Manage expectations.

14. Managing Quality: Define quality; Quality management process; Resolving quality issues; Quality assurance and control.

15. Managing Project Completion: Phasing out task/activities, meeting and questions; Close the project; Lessons learnt.

Reading lists:

1. Robbins & Caulter, *Management*, PHI 8th Edition
2. Koontz, *Principles of Management*, Tata McGrew Hill, 1st Edition 2008
3. Koontz, Weihrich; *Essentials of Management*, TMH, 5th Edition
4. P Gopalakrishnan, *Handbook of materials management*, PHI 5th
5. American national Standard; *A guide to Project management body of knowledge*, PMI
6. Harold Kerzner; *Project Management: A Systems Approach to Planning*, Scheduling, and Controlling, John Wiley & Sons, 10th Edition.
7. PMI; *A Guide to the Project Management Body of Knowledge*

Date: June 2011

Name of the Module	:	Hydraulic structures & Water power engineering
Module Code	:	FMH 401
Semester	:	VIII
Credit Value	:	12
Module Leader	:	Ms. Chimi Wangmo
Module Tutor	:	Ms. Chimi Wangmo and Mr. Ugyen Dorji,

General objectives or aims of the module:

To introduce the concepts, principles and applications of Hydraulics Structures & Water Power Engineering.

Learning outcomes:

Upon successful completion of this course the students will be able to:

1. Design various types of dams.
2. Evaluate the effect of sedimentation on the life of water retaining structures and select appropriate control measure.
3. Recognize the practical importance of hydraulic jump and energy dissipaters.
4. Select the cross drainage works for a given conditions.
5. Solve the problems of seepage through the body of hydraulic structures.
6. Solve the problem of water hammer.
7. Estimate the hydropower potential in Bhutan.

Learning and teaching approach used:

Lectures will introduce concepts and provide a broad background to the subject matter. Problem sheets give essential practice in applying the new knowledge to analytical and design examples. Tutorials….

Students are expected to support the module by reading from some of the suggested texts.

Lectures : 3-hrs/ week

Tutorial : 1 hr/week

Assessment:

Continuous Assessment - 30 marks (30%)

1. Assignment - 10 Marks.
2. Quiz& Class test - 10Marks
3. Mid-term test (2 Nos.) - 10 marks.

Semester End Examination - 70 marks (70%)

Written examination (Closed book exam of 3 hours duration) - 70 marks

Pre-requisite: Fluid Mechanics & Irrigation Engineering.

Subject matter:

Part A: Hydraulic Structures

1. **Reservoirs and Planning for Dam Reservoirs:** Definition & Types**,** Storage zones of reservoir, design capacity of reservoirs, reservoir losses, trap efficiency, reservoir sedimentation, life of a reservoir, preliminary investigation- selection of sites- selection of type of dam- classification of dams.
2. **Gravity Dams:** Forces acting on a dam- Modes of failure-safety criteria, principal and shear stresses, stability analysis-Elementary profile-Practical profile-design of gravity dams, construction of gravity dams- galleries, construction joints and water seals, foundation treatment of gravity dams.
3. **Spillways:** Types of spillways-design of Ogee spillway, principles of shaft, side channel, chute, and syphon spillways, energy dissipation, use of hydraulic jump as energy dissipater and design of stilling basin.
4. **Cross Drainage Structures:** Necessity of cross-drainage structures, types and selection, comparative merits and demerits, design of cross-drainage structures-aqueduct, siphon aqueducts, super passage, siphon.

Part B: Hydropower Engineering

1. **Introduction:** Sources and forms of energy, types of power plants, elements of hydropower scheme, hydropower development in Bhutan, Powerhouse structures-substructure and superstructure, layout and dimensions.
2. **Hydropower plant classification:** Surface and underground power stations, low, medium and high head plants, pumped storage plants, tidal power plants, Micro plants.
3. **Load and Power studies:** Estimation of hydropower potential-Flow duration curves-Power duration curves and load duration curves-load, capacity, Utilisation and diversity factors-Firm and secondary power-Storage and Pondage.
4. **Water Conveyance:** Intake, Penstocks - Economical diameter of Penstocks-Anchor blocks, Values-Basic principles of water hammer-Surge tanks, functions and types.

Reading List:

1. Asawa, G.L. (1996). *Irrigation Engineering* (2nd ed). New Delhi: New Age International Publishers 1996.
2. Barrows, H.K. (n.d). Water Power Engineering. New York: McGraw Hill Publishing Company.
3. Bhattacharya, P.K. (n.d). Waterpower Engineering. Delhi: Vikas Publications.
4. Dandekar, M.M., & Sharma K.N. (1994). Water Power Engineering. Delhi: Vikas Publishing Company.
5. Deshmukh M.M. (1978). Water Power Engineering. Delhi: Dhanpat Rai & Sons.
6. Garg ,S.K. (2008). Irrigation Engineering &Hydraulic structures (22nd ed). Delhi: Khanna Publishers.
7. Jog, M.G. (1989). Hydro-Electric & Pumped Storage Plants. Delhi: Wiley Eastern Limited.
8. Modi, P.N. (1994). Irrigation water Resources and Water Power Engineering. Delhi: Standard Books Company.
9. Murty, C. S. (1997). Water Resources Engineering -Principles & practice. Delhi: New Age international Publishers.
10. Punmia, B.C., & Pande B.B.L. (1990). Irrigation and waterpower engineering (11th ed) Standard Publisher distribution.
11. Sahasrabudhe, S.R. (1985). Irrigation Engineering and Hydraulic Structures (Including Hydrology& water power) (5th ed). Ludhiana: Katson Publishing House.
12. Sharma, R.K., & Sharma T.K. (2002). Irrigation Engineering (1st ed). Delhi: S. Chand & company Ltd.
13. Sharma, S. K. (1998). Design of Irrigation Structures (1st ed). Delhi: S Chand & Company.
14. Singh, B. (1983). Fundamentals of Irrigation Engineering (7th ed). Roorke: Nem Chand & Bros.
15. Singh, G. (1980). Irrigation Engineering"(1st ed). Delhi: Standard Book House.
16. Varshney, R.S., Gupta, S.C., & Gupta, R.L.(n.d). Theory and Design of Irrigation structures. Roorkee: Nem Chand & Bros.

Date: June 2011

Name of the Module	**:** Project
Module Code	**:** PRW401
Semester	**:** VIII
Credit Value	**:** 18
Module Leader	**:** Dr. Cheki Dorji

Module Tutor **:** All civil faculty

General objectives or aims of the module:

To familiarise the students with the planning, designing and execution of a project work by using their knowledge acquired during this course.

Learning outcomes:

Upon successful completion of this course the student will be able to

1. Appraise themselves with the processes involved in project execution.
2. Plan and estimate relevant project proposals.
3. Interpret the problem areas and contingencies.
4. Identify relevant remedial measures.
5. Predict the outcomes under similar conditions.
6. Infer technical reasons for the project outcome.

Learning and teaching approach used

Application and execution oriented learning enhances engineering judgement and skills development in the students.

Assessment

Continuous assessment - 70 marks (70%)

Regular Work (50 marks)

1. Actual work involvement (5 marks)
2. Team sprit & work culture (5 marks)
3. Conceptual understanding (5 marks)
4. Punctuality (5 marks)
5. Planning & execution/ compliance in carrying out guides instruction (5 marks)
6. Technical background materials collection (5 marks)
7. Analysis & interpretation capability (5 marks)
8. Time Management (5 marks)
9. Technical writing skills (5 marks)
10. Computational/logical ability (5 marks)

Report Evaluation (20 marks)

1. Theme of the project/ originality of the idea (4 marks)/
2. Realisability/ Practicality (3 marks)
3. Format & presentation/description style (2 marks)
4. Abstract/ Introduction (1 mark)
5. Reasons for specific mode of implementation (3 marks)
6. Information content (4 marks)
7. Conclusion/ analysis & finding (3 marks)

Semester End Examination - 30 marks (30%)

1. Presentation (10 marks)
2. External Viva (20 marks)

Pre-requisite:

Subject matter: Title identified in semester VII.

Reading list:
Current research topics from research journals and magazines.

Date: June 2011

Name of the Module	**:**	On the Job Training
Module Code	**:**	OJT401
Semester	**:**	VIII
Credit Value	**:**	0
Module Leader	**:**	Dr. Cheki Dorji
Module Tutor	**:**	All Civil Faculties

General objectives or aims of the module:
To familiarize the students with the practical aspects of their field of specialisation and to realize the adjustments required while implementing the theoretical knowledge for the real time project executions.

General objectives:
At the end of this module, students are expected to 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 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 students 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

Learning and teaching approach used:
All students are required to undergo practical attachment in relevant organizations as part of their degree courses. The period of attachment is 30 effective working days. The students will be sent on OJT at the end of 7th Semester. Students will follow the normal office working hours of the organization.

Assessment
The student's performance during attachment will be assessed and is considered as partial fulfillment for their Bachelor degree courses. Each student will be assessed individually:

Continuous (Field) Assessment – 50 marks (50%)

The supervisor of the student during the OJT will assess the students capability in the areas like – subject knowledge, punctuality, attitude, attendance, ability to solve the filed related problems etc. for a total marks of 50.

Examination – 50 marks (50%)

1. Report Evaluation – 20 marks.
2. Presentation – 30 marks.

Pre-requisite: All the Engineering Courses till Pre final year.

Subject Matter:

1. **Critical Appraisal:** An exercise in critical observation on an existing project, development from early concept design. Procedures adopted in decision making at inception level, series of changes in the process of approvals, constraints such as financial and human. Changes during the execution and changes done by the client after occupation - reason thereof. Users reaction on different aspects, student's personal remarks based on the faculties of balanced critical appraisal.
2. **Documentation of Innovative Details:** Documentation of innovative details from personal observations, office records or field studies. Critical observations of performance, usefulness etc
3. **Field Observation:** Observe, record and analyze the observations and to draw lessons from the study of any particular aspect.
4. **Office Training**: Students are required to be involved in all aspects of office work
5. **Site Supervision**: Students are to be exposed to different stages of construction on the site and to learn how the drawing of design is executed at the site by preparing a report to facilitates set of working drawings, sketches, annotated photographs etc, to supplement their observation.

Date: June 2011

DEPARTMENTAL ELECTIVE MODULES

Name of the Module : Geographic Information System and Applications
Module Code : SUR401
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:

To introduce the concepts of Geographic Information System (GIS) and its applications to Engineering.

Learning outcomes:

Upon successful completion of this course the student will be able to

1. Interpret spatial data and importance of GIS in Civil Engineering.
2. Anaylze spatial data in GIS software for various projects.
3. Input and manipulate and analysis the spatial and non spatial data.
4. Interpret data for various Engineering and other projects.

5. Processes satellite images and aerial photographs.
6. Integrate the GPS data to GIS data.

Learning and teaching approach used

The learners will be engaged including indicative hours.

Lectures : 3 hours/wk

Practical : 2hrs/wk

Assessment:

Continuous assessment – 50 marks (50%)

Assignment - 5 marks.

Mid term test - 10 marks.

Project - 5 marks

Presentations - 5 marks

Practicals

a) Evaluation regular practical works - 15 marks

b) Internal examination/ viva voice - 10 marks

Semester End Examination – 50 marks (50%)

Written examination (2hours) - 50 marks.

Pre-requisite: Introduction to computing and Photogrammetry and Remote Sensing.

Subject matter:

1. **Basic Concept of GIS:** Introduction - Information Systems, spatial and non-spatial information, Geographical concepts and terminology, Advantages of GIS, Basic components of GIS, Commercially available GIS hardware and software, organisation of data in GIS.
2. **GIS Data:** Input data – Field data, Statistical data, Maps, Aerial Photographs, satellite data, points, lines and areas features, Vector and Raster data, Advantages and Disadvantages, Data entry through keyboard, digitizer and scanners, Digital data, Processing of data – Rectification and registration, Interpolation techniques.
3. **Data Management:** Data Base Management System (DBMS), various data models, Run – length encoding, Quadtrees, Data Analysis – Data layers, analysis of spatial and non- spatial data, Data overlay and modelling. Data presentations – Hardcopy devices, softcopy devices.
4. **Applications of GIS:** Applications of GIS in Map Revision, Civil Engineering projects, Land use, Agriculture, Forestry, Archaeology, Municipal, Geology, water resources, Soil erosion, Land suitability analysis, Change detection.

Reading list

1. Paul A. Longley, Michael F. Goodchild, David J.Maguire, and David W, Rhind, (2001), *Geographic Information Systems and Science*. John Wiley and Sons Ltd.
2. Ian Heywood, Sarah Cornelius, Steve Carver, (1998), *An Introduction to Geographical Information Systems*. Longman publications, http://www.awi-he.com
3. Burrough, P.A. (1988): *Principles of Geographic Information System for Land Resources Assessmen*, Monograph on soil Resources Survey No.12, Claredon press, Oxford.
4. Legg, C.A. (1992): *Remote Sensing and Geographic Information Systems*, Ellis Horwood, London.

5. Campbell, J.B. (1986): *Introduction to Remote Sensing*, The Guilford Press.
6. Engaman, E.T and Gurney, R.J. (1991): *Remote Sensing in Hydrology*, Chapman and Hall, London.

Date: June 2011

Name of the Module : Building Design
Module Code : DOS402
Semester : VIII
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:
To introduce the concepts of building design and to compare the results with the software application.

Learning outcomes:
Upon successful completion of this course the student will be able to

1. Design a building.
2. Analyze the structures both manually and with the software.
3. Input and manipulate and analysis the spatial and non spatial data.

Learning and teaching approach used
The learners will be engaged including indicative hours.
Lectures : 3 hours/wk
Practical : 1hrs/wk

Assessment:

Continuous assessment – 30 marks (30%)

Assignment - 20 marks.
Mid term test - 10 marks.

Semester End Examination – 70 marks (70%)

Written examination (3hours) - 70 marks.

Pre-requisite: DOS302 and DOS401.

Subject Matter:

1. **Bye Laws**: Building Bye Laws and general requirements as per Bhutan Building Rules (for other buildings refer, National Building Code of India). Modular coordination.
2. **Design Loads**: Design loads for different types of buildings.
3. **Structural Systems**: Vertical and lateral load resisting elements, shear walls, framed tubes.
4. **Foundations for Multistoreyed Buildings**: Pile and Raft foundations.

5. **Masonry and Framed Buildings**: Design of masonry buildings and framed buildings, Earthquake resistant construction of buildings.
6. Slabs and Floors: Flat slabs, Grid floors.
7. **Mass Housing**: Prefabricated construction for mass housing including Light Gauge Steel Framed Buildings (LGSF Technology).
8. **Special Roofs**: Introduction to folded plates, Cylindrical Shells, north-light shell roofs.

Reading List:

1. Schueller, W. (1977), *High Rise Building Structures*, John Wiley and Sons
2. Saldori, M. and Levy, M., (1981), *Structural design in Architecture*, Prentice All Inc., New Jersey.
3. Krishna, Jai and Jain, (1997), *Plain and reinforced Concrete – Vol. II*, Nem Chand and Bros., Roorkee,
4. Jain, A.K., (1997), *Reinforced Concrete – Limit State Design*, Nem Chand and Bros., Roorkee, .

Date: June 2011

Name of the Module : Bridge Engineering
Module Code : DOS403
Semester : VIII
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:

To introduce the concepts of Bridge Engineering and design bridge.

Learning outcomes:

Upon successful completion of this course the student will be able to

1. Identify different components of bridges.
2. Determine different types of load acting on the bridge.
3. Design bridge

Learning and teaching approach used

The learners will be engaged including indicative hours.

Lectures : 3 hours/wk
Practical : 1hrs/wk

Assessment:

Continuous assessment – 30 marks (30%)

Assignment - 20 marks.
Mid term test - 10 marks.

Semester End Examination – 70 marks (70%)

Written examination (3hours) - 70 marks.

Pre-requisite: DOS302 and DOS401

Subject matter:

1. **General Considerations**: Types of bridges, economic spans, aesthetics, selection of suitable type of bridge.
2. **Design Loads and their Distribution**: IRC loads, analysis of deck slab for IRC loads, load distribution among longitudinal beams of a bridge.
3. **Design of Superstructure**: Design of balanced cantilever concrete bridge. Introduction to RC arch bridge, Prestressed concrete bridge and box girder bridge. Design of lattice girder bridge.
4. **Design of Substructure**: Different types of foundations, their choice and method of construction. Design of well foundation. Design of piers and abutments. Various types of bearings and their design.
5. **Construction Methods**: Introduction to construction methods, erection of bridge super structures, cantilever construction.

Reading List:

1. Victor, D.J., (1991), *Essentials of Bridge Engineering,* Oxford & IBH Publishing Co. Pvt.Ltd.
2. Raju, N.K., (1991), *Design of Bridges,* Oxford & IBH Publishing Co. Pvt.Ltd.,1
3. Ponnuswamy, S., (9186), *Bridge Engineering*, TMH, New Delhi,
4. Bakht, B. and Jaeger, L.G., (1987), *Bridge Analysis Simplified*, McGraw Hill Book Company,
5. Raina, V.k., (1991), *Concrete Bridge Practice*, McGraw Hill.
6. Pama, R.P and Cusens,A.R., (19975), *Bridge Deck Analysis*, John Wiley and Sons,

Date: June 2011

Name of the Module : Advance Surveying
Module Code : SUR402
Semester : VIII
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:

To introduce the concepts of Advance surveying.

Learning outcomes:

Upon successful completion of this course the student will be able to

a. Conduct survey using advance surveying equipments.
b. Use different types of advance surveying equipment.

c. Use different types of surveying softwares.

Learning and teaching approach used

The learners will be engaged including indicative hours.

Lectures : 3 hours/wk

Practical : 2 hrs/wk

Assessment:

Continuous assessment – 25 marks (25%)

Assignment - 15 marks.

Mid term test - 10 marks.

Practicals 25 marks (25%)

a) Evaluation regular practical works - 15 marks

b) Internal examination/ Quize/viva voice - 10 marks

Semester End Examination – 50 marks (50%)

Written examination (3hours) - 50 marks.

Pre-requisite: DOS302 and DOS401

Subject Matter:

1. **Modern Surveying Equipment**: Data and Equipment needed for engineering projects, Review of Traditional Surveying Equipment. Changing scene in Surveying and Mapping, Map substitutes, Use and advantages of Modern Surveying Equipment in projects. Modern Surveying Electronic Equipment, their principles, construction, working and use – Electronic Theodolites, E.D.M. Instruments – Geodimeter, Tellurometer, Distomat, Total Station. Application of Lasers in distance and angular measurements, Introduction to electronic navigation and position fixing – different systems and their characteristics.
2. **Global Positioning Systems**: Global Positioning system – working principle and methods. Different approaches to use GPS and their accuracies, Advantages of GPS in navigation, surveying, planning and mapping.
3. **Geographic Information System**: geographic Information System – data requirement and data base creation. Use of field data, maps, aerial and satellite data. Advantages of GIS.

List of Experiments:

1. To carry out the traversing using total station.
2. To determine the coordinates of traverse Stations using Total Station equipment.
3. Setting out buildings/structures using total station.
4. Global Positioning System (GPS) in static and kinematic mode to determine X, Y and Z measurements.
5. Digitisation of a map using GIS.
6. To conduct classifications in GIS

Reading List:

1. Arora, K.R., (1993), *Surveying – Vol. I, II and III*, Standard Book House, Delhi.
2. Bannister, A. and Baker, R., (1994), *Solving Problems in Surveying*, Longman Scientific Technical , U.K.
3. Burnside, C.D., (1991), *Electronic Distance Measurement*, Oxford, BSP Professional Books, London.
4. Kennie, T.J.M and Petrie, G., (1990), *Engineering Surveying Technology*, Blackie and Sons Ltd., London.
5. Laurila, S.H., (1983), *Electronic Surveying in Practice*, John Wiley & Sons, New York.
6. Wolf, P.R., (1996), *Elements of Photogrammetry*, McGraw Hill Book Company.

Date: June 2011

Name of the Module : Earthquake Engineering
Module Code : DOS404
Semester : VIII
Credit Value : 12
Module Leader : Mrs. Monika Thapa
Module Tutor : Mrs. Monika Thapa

General objectives or aims of the module:

The goal of this course is to introduce students to earthquake engineering studies as per the module descriptor and familiarize them to IS codes related to it. Teach them seismic analysis and design for engineering structures like buildings and shear walls. Also introduce them to softwares and help them analyse these problems using softwares (STAADpro).

Learning outcomes

Upon the successful completion of this course, the students will be able to:

1. Explain what is earthquake, what causes it, how it's measured and what are the instruments used to measure it.
2. Derive the seismic equations for different degrees of freedom and solve various problems related to single, second and multi degrees of freedom system.
3. Do seismic analysis and design using IS:codes manually and with the help of STAADpro.
4. Explain techniques which helps to make structure seismic resistant.

Learning and teaching approach used

The concepts of the earthquake engineering principles are introduced through lectures with examples and their application to the structures. This will be is followed by the explanation of seismic design steps for few typical structure as per the module using available text books, codes and software tools. The students are encouraged and developed by giving assignments. Advance techniques for making structures seismic resistance are also introduced and students are encouraged to brows net and look into recent case studies carried-out across the world.

Lectures : 3 hours/week
Tutorial : 1 hour/week

Assessment:

Continuous assessment – 30 marks (30%)

Assignment - 15 marks.

Mid term test - 10 marks.

Semester End Examination – 70 marks (70%)

Written examination (3hours) - 70 marks.

Pre-requisite: DOS302 and DOS401

Subject matter:

1. **Elements of Seismology**: Introduction to seismology, theory of plate tectonics and General features of tectonic of seismic regions, seismic waves, Definitions of Magnitude, Intensity, Epicenter etc, Seismographs and seismograms.
2. **Theory of Vibration**: Free Vibration of single degree, two degree and multiple degree freedom systems. Computation of dynamic response to time dependent forces. Vibration absorbers.
3. **Principles of Earthquake Resistant Design:** Response spectrums theory. Brief introduction to accerographs and SRR.'s. Nature of dynamic loading resulting from earthquakes. Application of Response spectrum theory to a seismic design of structures. Resistance of structural elements and structures for dynamic loads, design criteria-strength and deflection. Ductility and absorption of energy.
4. **Earthquake resistance design of structures:** building design and shear walls.
5. **Introduction to Indian Standard Codes:** IS:1893-1984 and IS: 4326-1993
6. **Retrofitting:** Introduction to retrofitting, Consideration in retrofitting of structures, Classification of retrofitting techniques, retrofitting strategies for RC buildings and purpose of retrofitting in buildings.
7. **Base-Isolation:** Introduction to base-isolation, Consideration for base-isolating structures, Types of base-isolation, base-isolating strategies for buildings, Need for base-isolating buildings, case studies from net.

Reading List

1. Pankaj Agrawal and Manish Shrikhande (2007), *Earthquake Resistant Design of Structures (1st edition).* New Delhi: Prentice Hall of India Pvt. Ltd.
2. Chopra, A.K. (1995), *Dynamics of Structures- Theory and Application to Earthquake Engineering*. New Delhi: Prentice Hall, NJ.
3. Paz Mario (2004), *Structural Dynamics (Theory and Computation)*. New Delhi. CBS publishers.

Date: June 2011

Name of the Module : Prestressed Concrete Structures
Module Code : DOS405
Semester : VIII
Credit Value : 12
Module Leader : Mrs. Monika Thapa
Module Tutor : Mrs. Monika Thapa

General objectives or aims of the module:

The goal of this course is to introduce students to prestressed concrete structures familiarize with prestressed concrete structures.

Learning outcomes

Upon the successful completion of this course, the students will be able to:

1. Explain prestressed concrete structures.
2. Design of prestresed concrete structures.
3. Explain of stresses induced in prestressed structures.

Learning and teaching approach used

Lectures : 3 hours/week

Tutorial : 1 hour/week

Self directed learning: 6 hours/week

Assessment:

Continuous assessment – 30 marks (30%)

Assignment - 15 marks.

Mid term test - 10 marks.

Semester End Examination – 70 marks (70%)

Written examination (3hours) - 70 marks.

Pre-requisite: DOS302 and DOS401

Subject Matter:

1. **Prestressing Systems, Materials and Codes**: Basic concepts, systems, materials and their properties, losses of prestress, I.S and I.R.C specifications.
2. **Design of Beams**: Analysis and design of section for bending and shear, bending of cables, limit state analysis and design, anchorage zone stresses, design of end block, application to bridges.
3. **Beam _Columns and Ties**: Sections subjected to bending and thrust, tension members, circular prestressing.
4. **Circular Prestressing**: Equipment and applications.
5. **Continuous Beams and Portal Frames**: design concepts, concardancy of cables, Secondary design considerations.
6. **Partial Prestressing**: Principles and advantages.

Reading List:

1. Dayaratnam, P., (1991), *Prestressed Concrete Structures*, Oxford and IBH Publishing co. Pvt. Ltd, New Delhi.
2. Lin, t.Y. and and Burns, N.H., (1982), *Design of Prestressed Concrete Structures*, John Wiley and Sons.
3. Nilson, A.H., (1978), *Design of Prestressed Concrete*, John Wiley and Sons.
4. Naamam, A.E., (1982), *Prestressed Concrete Analysis and Design,* McGraw Hill Publishing Company,
5. Raju, N.K., (1995), *Prestressed Concrete,* McGraw Hill Publishing Company,

Date: June 2011

Name of the Module : CAD in Civil Engineering
Module Code : DOS406
Semester : VIII
Credit Value : 12
Module Leader : Mrs. Monika Thapa
Module Tutor : Mrs. Monika Thapa and Mr. Ugyen Tenzey

General objectives or aims of the module:

The goal of this course is to develop the skills of developing simple programs for analysis and design problems in civil engineering using C^{++} language and software tools. Also, to develop the skills in the areas of computer aided drafting, simulation and optimisation studies.

Learning outcomes

Upon the successful completion of this course, the students will be able to:

1. Explain the engineering design principles and interactive design principles.
2. Develop simple programs using C++ language for civil engineering analysis and design problems.
3. Develop the data structures including their design.
4. Use the available software tools to find the solutions for civil engineering problems.
5. Develop the simple programs for simulation and optimisation studies in civil engineering.

Learning and teaching approach used

The concepts of the various design principles are introduced through lectures with examples and their application to real time structural designs. This will be followed by the explanation of design steps for few typical structures and their components using available software tools. The students are encouraged to develop simple programs for civil engineering related problems on their own to consolidate their design approaches and methods through tutorials/assignments using the CAD laboratory facilities.

The time allocated for these activities are given below.

Lectures : 2 hours/week
Tutorial : 1 hour/week
Practicals : 2 hours/week

Assessment:

Theory

Continuous assessment - 25 marks (25%)

1. Assignments - 10 marks.
2. Mid term test - 10 marks
3. Class test - 5 Marks

Semester End Examination: 50 marks (50%)

Written examination (3 hrs duration) – 50 marks

Practical:

Continuous assessment - 25 marks (25%)

1. Evaluation of regular practical works - 15 marks.
2. Internal Practical examination/ viva-voce - 10 Marks

Pre-requisites: Structural Mechanics, Fluid Mechanics and Design of Concrete Structures.

Subject matter:

1. Programming Language (C++ Language) and engineering design principles.
2. Development of simple programs for analysis and design problems in Civil Engineering.
3. Interactive design using software tools.
4. Computer aided drafting, data base management system, simulation and optimisation.

Reading List:

1. Shesha Prakash M.N. and Suresh G.S, (2006). *Reference Book on Computer Aided Design Laboratory (1st edition)*. Laxmi Publication Pvt. Ltd.
2. Khandare S.S (2001*). Computer Aided Design (3rd edition)*. Charotar Publishing House.
3. Ravindran, D., *Programming with C++*. New Delhi: Tata McGraw Hill publishing.
4. Yashvant P.Katnetkar. *Let Us C++ (1st edition)*. BPB Publication.
5. John R. Hubbard. *Programming with C++ (2nd edition)*. New Delhi: Tata McGraw Hill Publishing.
6. Nicolai M. Josuttis (2003). *Object Oriented Programming in C++ (1st edition)*. John Willey and Sons Ltd.
7. Venugopal K.R, Kumar Raj and Ravishankar T. *Mastering C++*. New Delhi: Tata McGraw Hill Publishing.
8. Krishna Raju N and Pranesh R.N (2003). *Reinforced Concrete Design (1st edition)*. New Delhi: New Age International (P) Limited Publishers.
9. Syal, I.C. and Ummat, R.K., (1992). *Analysis and Design of Reinforced Concrete Elements*, Allahabad: A.H. Wheeler and Co.
10. Schied, S., *Theory and Problems of Computers and Programming*. New Delhi: Tata McGraw Hill Publishing.

Date: June 2011

Name of the Module : Water Resource Planning and Management
Module Code : EVE401
Semester : VIII
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:

The goal of this course is to introduce students to water resource planning and management.

Learning outcomes

Upon the successful completion of this course, the students will be able to:

1. Derive catchment area for the rivers and streams.

2. Formulate water resource projects
3. Assess the availability of water resource
4. Manage water resources
5. Model water resources

Learning and teaching approach used

Lectures : 3 hours/week
Tutorial : 1 hour/week

Assessment:

Continuous assessment – 30 marks (30%)

Assignment - 15 marks.
Mid term test - 15 marks.

Semester End Examination – 70 marks (70%)

Written examination (3hours) - 70 marks.

Pre-requisite:

Subject matter:

1. **Introduction**: Role of water in national development, assessment of water resources of country, scope of water resources development vis-à-vis environment.
2. **Planning**: Water resources planning process; Planning for single purpose and multipurpose projects, estimation of different water needs and project formulations, comparison of alternatives; Cost-benefit analysis; Introduction to optimization techniques and systems approach.
3. **Management**: Evaluation and monitoring of water quantity and quality, managing water distribution networks for irrigation, flood control and power generation, inter-basin transfer of water, conjunctive use of surface and ground water, water quantity and quality modeling, evaluation of impacts of water resources projects on river regimes and environment, reservoir sedimentation and watershed management.

Reading List:

1. Good Man, A.S., (1984), *Principles of Water Resources Planning*, Prentice Hall Inc., Englewood Cliffs, N.J.
2. Linsley, R.K. and Franzini, J.b, (1979), *Water Resources Engineering*, McGraw Hill, New York.

Date: June 2011

Name of the Module : Environmental Geotechnology
Module Code : EVE402
Semester : VIII
Credit Value : 12

Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji and Ms. Chimi Wangmo

General objectives or aims of the module:
The goal of this course is to introduce students to environmental geotechnology and explore the best practices.

Learning outcomes
Upon the successful completion of this course, the students will be able to:

1. Uses of geosynthetics
2. Identify suitable sites for landfill.
3. Plan solid waste management.
4. Identify subsurface containment
5. Formulate regulations for solid wastes

Learning and teaching approach used
Lectures : 3 hours/week
Self directed learning: 6 hours/week

Assessment:
Continuous assessment – 30 marks (30%)
Assignment - 15 marks.
Mid term test - 15 marks.

Semester End Examination – 70 marks (70%)
Written examination (3hours) - 70 marks.

Pre-requisite:

Subject Matter:

1. **Introduction**: Scope; Importance; Waste generation; Subsurface contamination.
2. **Geosynthetics**: Types of geosynthetics; Manufacturing; Functions; Applications and economics.
3. **Forms of Waste and their Engineering Properties**: Municipal waste, mineral waste, industrial waste, hazardous waste; Index Properties; Strength, compressibility and permeability of municipal waste and mineral waste.
4. **Selection of Waste Disposal Sites**: Factors effecting site selection; Siting criteria and siting rating method.
5. **Landfills for Municipal and Hazardous Waste**: Components of landfills; layouts; Daily cells; Basal lining systems; Stability of slopes; Construction aspects.
6. **Ash Ponds and Mine Tailing Impoundments**: Slurry deposition of mine tailing and coal ash in impoundments; Layout, components; Design of tailing dams/ash dykes; Slope Stability.
7. **Site Investigations for Detection of Subsurface Contamination**: Objectives; Planning; Soil drilling and sampling; Monitoring wells; Pore-gas samplers; Pore-fluid samplers; Geophysical methods.

8. **Remediation**: Principles of remediation; Planning for remediation; Source control; Pump and treat; Soil-gas extraction; Soil washing; Bio-remediation.
9. **Geotechnical reuse of Waste Materials and Fills**: Use of waste material in embankments, abutments and fills for low lying areas.
10. **Mechanics of Erosion and Erosion Control Methods**: Erosion due to wind, rain and water ways; Erosion control by @-D elements, biotechnical methods, and 3D techniques; Erosion control of waterways.
11. **Landslides and Their Control**: Types of landslides; causes; Mechanisms; Analysis, investigations; Control measures; Remediation.
12. **Regulations**: Regulations governing solid waste disposal and ground water contamination.
13. **Site Visits**: Visit to landfill site and landslide site.

Reading List:

1. Owesis, I.S and Khera, R.P., *Geotechnology of Waste Management*, Butterworths, London,
2. Daniel, D.E., *Geotechnical Practice for Waste Disposal*, Chapman and Hall, London,
3. Rao, G.V., *Erosion Control with Geosynthetics*, C.B.I.P, New Delhi,
4. Rao, G.V and Raju, G.V.S.S., *Engineering with Geosynthetics*, (Edited Book), TMH,
5. Vick, S.G., *Planning, Design and Analysis of Tailing Dams*, John Wiley, New York,
6. Zaruba, R. and Mencl, V., *Landslides and their Control*, Elsevier, Developments in Geotechnical Engineering,
7. Goumans, J.J.M, Vanderstoot, H.A and Alberts, T.G., *Environmental Aspects of Construction with Waste Materials*, Elsevier Science,
8. Valdiya, K.S., *Environmental geology,* TMH, New Delhi,
9. Bromhead, E.N.,*The Stability of Slopes*, Chapman and Hall, London,

Date: June 2011

Name of the Module : Photogrammetry and Remote Sensing
Module Code : SUR403
Semester : VIII
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji

General objectives or aims of the module:

To introduce the photogrammetry and Remote Sensing as a subject. Enable the student to use subject in civil engineering applications.

Learning outcomes:

Upon successful completion of this course the student will be able to

1. Interpret and analyze the Aerial Photographs for various Civil Engineering Applications
2. Take the measurements from aerial photographs using photogram metric techniques to plan civil engineering sites.

3. Interpret and analyze the Satellite remote sensing images for various Civil Engineering applications
4. Learn how to procuring of Remote Sensing data from agencies and data servers.
5. Learn to processes remote sensing images using digital image processing softwares.
6. Learn to prepare the data base and analyze the geodatabase for various application in GIS (Geographic Information Systems).
7. Learn how to use GPS for advanced surveying.

Learning and teaching approach used

The following list is the types of learning experiences in which the learners will be engaged including indicative hours. Laboratory practical will conduct based on theory is given in lecturer hours. Case study/ mini project should take in the subject area and analyse and present in the class.

Lectures : 3 hours/wk

Practical : 2 hours/wk

Assessment: The achievement of the learning outcomes is assessed in the following manner.

Theory:

Continuous assessment – 25 marks (25%)

1. Assignment - 10 marks.
2. Mid term test – 10 marks.
3. Project (mini) – 5 marks

Semester End Examination – 50 marks (50%)

Written examination (2hrs, closed book) - 50 marks

Practicals:

Continuous assessment - 25 marks (25%)

1. Regular assessment of the experiments – 15 marks.
2. Practical examination/quize/viva voce – 10 marks

Pre-requisite: None

Subject matter:

1. **Photogrammetry:** Definition of Photogrammetric Terms, Geometry of terrestrial photographs, Aerial camera and photo-theodolite, Scale of a photograph, Tilt and Height displacements, Stereoscopic vision and stereoscopes, Height determination from parallax measurements, Flight planning, Maps and map substitutes and their uses.
2. **Remote Sensing:** Introduction to Satellite Remote Sensing; energy source and radiation principles; Atmospheric windows, remote sensing systems, platforms, Orbital parameters of a satellite, multi-spectral scanners; thermal infrared line scanners, sideway looking airborne radar; Microwave Sensor: Passive and active, data acquisition from Landsat, ERS, SPOT and IRS satellites, digital enhancement techniques; digital image analysis: visual, digital and classification accuracy. Introduction to GIS and GPS applications of remote sensing for civil engineering, Earth resources management.
3. **Image Processing:** Principles of interpretation of aerial and satellite images, equipments and aids required for interpretation, ground truth-collection and verification, advantages of multidate and multiband images. Digital image processing concept.

4. **Global position system:** working principle and methods. Different Approaches to use GPS and their accuracies, Advantages of GPS in Navigation, Survey, Planning and Mapping.
5. **Geographic Information system:** data requirement and data base creation. Use of field data, maps, aerial and satellite data. Advantages of GIS.

Practicals:

1. Study and comparison of aerial photograph and the same area.
2. Determination of average scale of a given aerial photographs and the flying height of the aircraft.
3. Test for stereovision using a test card under pocket stereoscope.
4. Base lining of a stereo-pair, using a mirror stereoscope.
5. Practice of taking parallax bar (stereometer) readings of given points of varying elevations.
6. Determination of elevations of given points on a pair of overlapping photographs including drawing of correction contours.
7. Landuse/landcover classification from False colour composite Satellite data.
8. Demonstration on Digital Image processing system.
9. Practical on GPS Survey

Reading list

1. Jensen J. R., (2003), *Remote Sensing of the Environment and Earth Resource Perspective,* Pearson Education. Delhi.
2. Lillesand T.M. and Kiefer R.W., (1994), *Remote Sensing and Image Interpretation*, John Wiley & Sons, New York.
3. Wolf P.R. (1996), *Elements of Photogrammetry*, Tata McGraw Hill Book Company, New Delhi.
4. Sabins F.F., (1997), *Remote Sensing: Principles and Interpretation*, W.H Freeman and Company, New York.
5. Campbell J.B., (1983), *Introduction to Remote Sensing*, Taylor & Francis, London, 1996.
6. Colwell R.N. (1983), *Manual of Remote Sensing, Vol. I & II*, American Society of Photogrammetry, Falls Church, Virginia.
7. Joseph G., (2003), *Fundamentals of Remote Sensing*, Universities Press, New Delhi.
8. Curran,P.J, (1985), *Principles of Remote Sensing*, Longman, London.
9. Kennie,T.J.M and Petrie, G., (1990), *Engineering Surveying Technology*, Blackie & Sons Ltd, London.

Date: June 2011

Name of the Module : Rural Water Supply and Sanitation
Module Code : EVE403
Semester : VIII
Credit Value : 12
Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji

General objectives or aims of the module:

To introduce the rural water supply and its distribution system to enable the student to apply the skills.

Learning outcomes:

Upon successful completion of this course the student will be able to

1. Design rural water supply scheme.
2. Select and identify the rural water supply sources.
3.

Learning and teaching approach used

The following list is the types of learning experiences in which the learners will be engaged including indicative hours.

Lectures : 3 hours/wk

Assessment: The achievement of the learning outcomes is assessed in the following manner.

Theory:

Continuous assessment – 30 marks (30%)

i) Assignment - 20 marks.
ii) Mid term test – 10 marks.

Semester End Examination – 70 marks (70%)

Written examination (3hrs, closed book) - 70 marks

Subject matter:

1. **General**: Concept and scope of environmental sanitation in rural areas, Magnitude and problems of water supply and sanitation in rural areas in Bhutan, National Policy.
2. **Water Supply**: Quality aspects – specific impurities and their significance, design population, demand and variations, planning of water supply schemes in rural areas, individual village and group schemes. Sources of water supply – springs, wells, infiltration wells, radial wells, infiltration galleries and surface water intake, treatment of water for rural water supply. Compact system – multi bottom settler, slow sand filter, diatomacesus earth filter, cloth filter, chlorine diffusion cartridges. Pumps, pipe, materials, appurtenances and improvised device for use in rural water supply schemes, Distribution systems for rural water supply.
3. **Disposal of Night Soil and Waste Water**: Various methods of collection and disposal of night-soil – sanitary latrines, community latrines, septic tanks, soakage system, anaerobic filter, Imhoff tank. Compact and simple waste water treatment plants. Stabilisation ponds, revolving biological surface.

Reading List:

1. Wagner, E.G. and Lanoix, J.N., *Water Supply for Rural Areas and Small Communities*, WHO monograph, Series No.42,
2. Wright, F.B., *Rural Water Supply and Sanitation*,
3. Wagner, E.G. and Lanoix, J.N., *Excreta Disposal for Rural Areas and Small Communities*, WHO monograph, Series No.39,

Date: June 2011

Name of the Module : Traffic Engineering

Module Code : TRA401

Semester : VIII

Credit Value : 12

Module Leader : Dr. Cheki Dorji
Module Tutor : Dr. Cheki Dorji

General objectives or aims of the module:
To introduce the traffic planning and design as a subject and to enable the student to determine the traffic safety.

Learning outcomes:
Upon successful completion of this course the student will be able to

1. Identify the traffic problems
2. Design parking facilities.
3. Determine vehicle flow characteristics.
4. Determine speed of the vehicles.
5. Design traffic facilities.
6. Identify traffic problems and suggest measures.

Learning and teaching approach used
The learners will be taught using case studies and examples within the indicative hours. Field trips will be arranged to observe the existing problems.

Lectures : 3 hours/wk

Assessment: The achievement of the learning outcomes is assessed in the following manner.
Theory:

Continuous assessment – 30 marks (30%)

i) Assignment - 15 marks.
ii) Mid term test – 15 marks.

Semester End Examination – 70 marks (70%)

Written examination (3hrs, closed book) -70 marks

Subject matter:

1. **Introduction**: 3E's of traffic engineering, Special problems due to mixed traffic and other conditions in developing countries.
2. **Traffic Characteristics**: Road user characteristics, Vehicular characteristics, Taffic flow characteristics, Capacity, Traffic studies, Volume, Spot speed, Speed and delay, Origin and destination, Parking and accidents.
3. **Traffic Facilities Design**: Design of intersection – rotary intersections, grade separated intersection. Design of off- street parking facilities.
4. **Traffic Operation and Safety**: Traffic regulation, Controls on vehicles, Drivers and flow, One way street tidal flow operation, priority of high occupancy vehicles. Traffic control devices – signs, signals, Islands and markings. Design of isolated traffic signals by IRC method. Analysis of traffic accidents, Highway lighting, Effect of road conditions and road geometrics on traffic safety, Traffic safety awareness.
5. **Traffic and Environment**: Pollution problems of cities, Noise pollution, Air pollution, Vibration, Environmental Impact Assessment, Mitigative measures.

Reading List:

1. Mcshane, W.R and Roes, R.P, *Traffic Engineering*, Prentice Hall , New Jersey,
2. Flaherty, CAO' (Ed.), *Transport Planning and Traffic Engineering*, John Wiley and Sons Inc., New York,
3. Kadiyali, L.R., *Traffic Engineering and Transport Planning*, Khanna Publishers, Delhi,
4. May, A.D., *Traffic flow Fundamentals*, Prentice Hall , New Jersey,

Date: June 2011