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
- Self Directed Learning : 6 hrs/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. 3 hrs written examination (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 (8^{th} edition). *Advanced Engineering Mathematics*. Wiley Student Edition.
2. Dr. Grewal, B.S. (40^{th} edition-2007). *Higher Engineering Mathematics.* New Delhi: Khanna Publishers
3. Das, H.K (14^{th} 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: 3 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=nλ, 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: 3 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: 3 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
- Self study : 5 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

1. 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: 3 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
Self study	:	5 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: 3 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
- Self Directed Learning : 6 hrs/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: 3 June 2011

Name of the Module	**:**	Engineering Physics – II
Module Code	**:**	PHY102
Semester	**:**	II
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 in a variety of technical positions. This will develop skills in formulating and applying physics principles based on the data and provide the student with scientific reasoning as a basis in solving concrete problems.

Learning outcomes:

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

1. Discuss different types of electrical materials, their properties and applications.
2. Describe the fundamental properties of electric charges and the nature of electrostatic forces between charged bodies.
3. Use Coulomb's law and superposing principle to determine the net electrostatic foe on a point electric charge.
4. Solve mathematical problems involving electric fields and forces using appropriate mathematical techniques.
5. Solve problems involving Gauss's law and electric flux.
6. Explain the distribution of charge in and on a conductor a in electrostatic equilibrium, as well as the properties of electric fields inside and outside the conductor.
7. Use Biot-Savart law and Ampere's law to calculate the magnetic field induction.
8. Distinguish magnetic material.
9. Explain particle properties of waves and wave properties of particles.
10. Understand the different form of nuclear energy.
11. Explain properties, characteristics and uses of lasers.
12. Identify super conducting materials and recognize their applications.

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 (75%)**

  Continuous Assessment - 25 marks (25%)

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

3. Class Test - 5marks

Semester End Examination- 50marks (50%)

1. Written examination (3 hours) – 50 marks

- **Practical continuous Assessment - 25 Marks**
  1. Regular Laboratory assessment – 15 marks as shown in annexure - I
  2. Viva – 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. **Conducting, magnetic and dielectric materials:** Resistivity of metals, Mathiesson,s Nordheim.s rule, Cu, Al, Steel and other conducting materials, High resistivity alloys, Bimetals and thermo couples, Dia, Para and Ferro magnetism, Ferri and anti ferromagnetisms, magnetic domains, Soft and hard magnetic materials, Dielectric materials, Field vectors and their relation, Ferroelectric and piezoelectric materials, Classification of insulating materials, Electrical Characteristics, Mechanical Properties, Thermal properties and Applications of Insulating materials
2. **Electromagnetism:** Quantization & conservation of charge; Coulomb's law (vectorial form) and superposition principle; Concept of electric field lines, flux of E-field, Gauss's law; Electric Potential energy and potential; Magnetic field, Force on a moving charge in a magnetic field; Force on current element; Torque on current loop; Biot-Savart law; Ampere's law; Electromagnetic induction and Faraday's law; Magnetism in materials; Maxwell's equations; Electromagnetic Waves.
3. **Modern Physics**: Elements of wave properties of particles; particle properties of waves; Solid State Devices, Semiconductors and p-n junction; Nuclear Energy; Lasers. Type I and type II superconductors, Thermodynamics of super conductors, BCS Theory, Cooper pairs, High temperature super conductors, DC and AC, Josephson effects, applications of high temperatures super conductors.

Reading list:

1. A.J. Dekkar (2002), "Electrical Engineering Materials", Prentice Hall Pvt. Ltd. New Delhi
2. Rangwala and Mahajan (1998), "Electricity and Magnetism", 15th edition, Tata McGraw Hill, New Delhi.
3. Verma, H.C (1993), "Concepts of Physics, Part-2", 1st edition, Bharati Bhawan (P&D), New Delhi.
4. Beiser (1995), "Modern Physics", 5th edition, McGraw-Hill Inc., New York.
5. Mani and Mehta, G.K. (1998), "Modern Physics", Affiliated East-West Press Pvt. Ltd.
6. Gaur R.K and Gupta, S.L (2001), " Engineering Physics, 8th edition, Dhanpat Rai Publications, New Delhi.

Date: 3 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
Self study	:	5 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 Practical's:

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: 3 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
- Self study : 6 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 Practical's:

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: 3 June 2011.

Name of the Module	**:**	**Academic Skills**
Module Code	**:**	**ACS 101**
Semester	**:**	II
Credit Value	**:**	12
Module Leader	**:**	Miss Pema Choezom
Module Tutor	**:**	Miss 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

References

** 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.).

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*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

Name of the Module	**:**	Electrical Workshop Practice
Module Code	**:**	EWP101
Semester	**:**	II
Credit Value	**:**	**6**
Module Leader	**:**	Mrs. Pema Youden
Module Tutor	**:**	Mrs. Pema Youdon & Mr. Sangay Dorji

General objectives or aims of the module:
To develop the basic concept on the safety measures, use and specify common electrician tools and wiring accessories, earthing and carry out maintenance in wiring system.

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

1. Understand basic safety rules and precaution to be followed while working
2. Specify basic electrician tools and wiring accessories
3. Identify and locate electrical faults in wiring system
4. Carry out electrical wiring maintenance
5. Differentiate different types of earthing and chose proper earthing for electrical works

Learning and teaching approach used

Theory	:	1 hour per week
Practical	:	3 hours per week
Self study	:	3 hours per week

Assessment

Continuous assessment-70 marks
Viva/Test – 30 marks

Students must obtain 40% each in the Continuous assessment of theory and practical. The overall pass mark for the module is 50%.
Subject matter:

ELECTIRCAL WORKSHOP PRACTICE (0 0 3)

1.Electrical Installation practice:

Introduction to basic electricity

Safety: Safety rules and precautions, Methods for electric shock treatment,

Tools: specifications of electrician's tools, factors governing the specification of tools

Measuring instruments: specification of commonly used measuring instruments in power systems and applications

Joints and soldering: Importance of joints, safety procedure to be observed while constructing various types of joints including cable joints

Wiring accessories: specifications of various wiring accessories and their applications

Wiring practices: conduit and casing capping wiring

2. EARTHING

Various types of earthing, Pipe or plate earthing as per standard code of practice and earth resistance test by earth tester

3. WELDING PRACTICE

Hand on practice on Arc welding

4. MAINTENANCE OF WIRING INSTALLATION

Carrying out electrical maintenance as required, in close co-ordination with the electrical maintenance in-charge. Discussion on nature of fault, Tracing of electrical faults, Repair and maintenance work. Faults in distribution network, maintenance work (find out the possible area in the campus).

Note:

1. Students should be enforced to follow safety precautions and apply the same for all the workshop practice.
2. Basic theory should be explained before practice. Discussion and explanation should take place as required during practice

Reading List:

1. Wadha, C L 2006, Generation, Distribution and Utilization of Electrical Energy, Wiley Eastern Limited, New Delhi.
2. Bhatia, S L 2006, Handbook of Electrical Engineering, Khanna Publishers, New Delhi.
3. AutoCAD 2005 Manual

Date : 3 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
- Self Directed Learning : 6 hrs/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.
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7. Murray R. Spiegel (1965), "Theory and Problems of Laplace Transorms", Schaum's Outline Series, McGraw-Hill Book Company, Singapore.

Date: 3 June 2011

Name of the Module	**:**	Circuit Theory-I
Module Code	**:**	CKT201
Semester	**:**	III
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mr. Manoj Sharma

General objectives or aims of the module:

This module will make the students recognize various network elements their properties and significance, principles of different network theorems and their applications in network analysis. It will enable students to understand and analyze the conditions of voltage and current magnifications at circuit elements. It will make the students understand the poly phase systems utility and intricacies.

Learning outcomes:

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

1 Recognize different circuit elements, their properties and applications.
2 Differentiate between direct and alternating forms of supply source.
3 Acknowledge the function of a source as a constant current or constant voltage provider depending upon the terminal load conditions.
4 Utilize different network theorems for convenient network simplification and analysis.
5 Formulate network matrices and integrate them with the primitive network information to represent an interconnected system.
6 Use graphical techniques to simplify the interconnected system information for mesh and nodal forms of analysis.
7 Distinguish between phasor notations of lag and lead networks.
8 Construct locus diagrams for different resonant circuit responses in frequency domain.
9 Apply the poly phase concepts to balanced load operations.
10 Analyze the series and parallel resonance conditions in ac circuits.

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. 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.

- Lectures : 3 hours per week
- Tutorial and Computer based simulation session : 1 hour per week
- Laboratory practicals : 2 hours per week
- Self study : 4 hours per week

Assessment:

- **Theory – 75 marks**
  Continuous assessment 25 marks
  4. Assignment - 10marks
  5. Closed book mid Term Test - 10marks
  6. Class Test - 5marks

  Semester End Examination – 50 marks
  2. Written examination (Closed books): 3 hours.
- **Practical continuous Assessment - 25 Marks**
  3. Regular Laboratory work – 15 marks as shown in annexure - I
  4. 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. **Basic Circuit Concepts:** Circuit elements(R, L, C, M); Independent and dependent sources; Coupled Circuits and transformers; Nodal and loop analysis; Source transformation; Star-Delta transformation; Ac fundamentals.
2. **Network Theorems:** Superposition theorem; Thevenin's and Norton's theorem; Tellegen's theorem; Maximum Power Transfer Theorem; Millman's theorem; Substitution theorem; Reciprocity and Compensation Theorem for dc and ac networks.
3. **Network Topology:** Terminology; Network matrices (Incidence, Reduced Incidence, Tie set and Cut set matrices); Generalised network representation and equations formulation; Duality and dual networks.
4. **Resonance:** Series and parallel Resonance; Quality Factor; Voltage across elements of Series resonant circuit, Currents in elements of parallel resonant circuit; Selectivity of series and parallel resonant circuits; Band width; Series parallel circuit transformation; Locus Diagrams.
5. **Polyphase Circuits:** Polyphase sources and circuits; Balanced 3-phase sources with balanced and unbalanced loads; V-I relations in three phase circuits connected in Y and Δ. Power measurement in 3-phase circuits.
6. **Fourier Analysis of Electrical Waveform:** Even and odd functions, Fourier analysis of rectified wave, triangular wave, saw-tooth wave, sinusoidal and co-sinusoidal waves.

List of Practical:

1. Verification of Superposition Theorem
2. Verification of Thevenin's and Norton's Theorem.
3. Verification of Tellegen's theorem and Maximum power transfer theorem.
4. Verification of Milliman's Theorem.
5. Verification of Substitution and Reciprocity theorem.
6. Verification of Compensation Theorem.
7. Determination of coupling coefficient and dot convention of coupled coils.
8. Series Resonance and voltage magnification.
9. Parallel Resonance and Current magnification.
10. Phase lead network and plots of V, I –phasors.

Reading list

1. S. Badrinarayan and Usha Nandini (2004), "Electric Circuit Theory", 1st edition, Scitech Publications Pvt Ltd.
2. D. Chattopadhyay and P.C. Rakshit (2004), "Fundamentals of Electric Circuit Theory", 6th edition, S. Chand & Company Ltd. New Delhi.
3. D. Roy Choudhury (2002), "Networks and Systems", 1st edition, New Age International Pvt. Ltd. publishers, New Delhi.
4. J.A. Edminister (1996), "Electric Circuits", 1st edition, Tata Mc Graw Hill Publishing Company, New Delhi.
5. S.C. Gupta, J.W. Bayless and B. Peikanri, (2001), "Circuit Analysis", 1st edition, New Age International Private Ltd, New Delhi.
6. R. C. Dorf and J.A. Svoboda (2004), "Introduction to Electric circuits" 6th edition, John Wiley and Sons Pvt Ltd. Singapore.

Date: 3 June 2011

Name of the Module	**:**	Electrical Measuring Instruments
Module Code	**:**	EMI201
Semester	**:**	III
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mr. Sonam Norbu

General objectives or aims of the module:

This module will introduce various standards and unit systems used in measurements; various measuring meters analog & digital used for measurement of various electrical quantities and measurements applicable in electrical engineering.

Learning outcomes:

1. At the end of this module, students are expected to be able to:
2. Describe different unit systems and will be able to solve different kinds of problems.
3. Determine values of unknown resistance ,voltage, current & flux density
4. Sketch the hysteresis loop of various specimens.
5. Recognise different kinds of bridges and use them for measurement of unknown inductance, capacitance, resistance, mutual inductance and frequency.
6. Analyse the construction and working principle of different types of ammeters, wattmeters, energy meters, maximum demand indicator and power factor meter.
7. Use CRO.

Learning and teaching approach used

- Lectures : 3 hours per week
- Laboratory practical : 2 hours per week
- Self study : 7 hours per week

Assessment:

- **Theory – 75 marks**

  Continuous assessment - 25 marks

  1. Assignment : 5 marks
  2. Class Tests (closed book) : 5 marks
  3. Mid –Term test : 10 marks
  4. case study : 5 marks

  Semester End Examination - 50 marks

  1. Written examination : closed book, 50 marks,3hrs

- **practical – 25 marks**

  1. Continuous Laboratory assessment - 15 marks as shown in annexure - I
  2. Test/Viva - 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. **Standards of Measurement & Errors:** S.l Units, Voltage standards, Errors, Static & Dynamic characteristics of Electrical Instruments
2. **Galvanometers:** Galvanometer equation in D.C. Measurements, D'Arsonval type, Vibration type and Balastic type.
3. **RLC Measurement:** D.C. and A.C Potentiometers, Polar and Coordinate A.C. Potentiometers, Standardization, Basic concept of Self Balancing Potentiometer and its applications.EE403 Measurement of low, medium and high resistances, Insulation resistance of insulating material, Volume and Surface resistivity measurement, Earth resistance measurement, Cable fault location, Bridges for inductance & mutual inductance measurement - Maxwell, Anderson, Hay, Owen and Haviside Campbell bridges, Bridges for capacitance measurement - DeSauty, Wien, Schering Bridge, Basic concept of Self Balancing Bridge and its applications(EE403)
4. **Instrument Transformers:** Purpose, theory, error analysis and compensation, Testing and applications.
5. **Magnetic Measurements:** Purpose and methods of measurement, Choice of specimen and determination of hysteresis loop, Permeability and iron loss measurement, A.C. magnetic measurement
6. **Electrical Instruments:** Ammeters and Voltmeters, Wattmeters, operation, Energy meters for d.c. and a.c, Special Meters - Maximum demand indicators, power factor meters for 1-phase and 3-phase system, synchroscopes, Megger, CRO, Analog Electronic Instruments(chap 1 & 2 of EE403 can be added here).
7. **Measurement of power:** Measurement of active and reactive with 2- wattmeter method.

Reading list:

1. Sawhney A.K. (1996), "A course in Electrical and Electronic Measurement and Instrumentation", Dhanpat Rai and Sons, New Delhi.
2. Golding E.W. (1979), "Electrical Measurements and measuring instruments", A W Wheeler and Company Pvt. Ltd, New Delhi.

Date: 3 June 2011

Name of the Module	**:**	Electronics-I
Module Code	**:**	ELE201
Semester	:	III
Credit Value	**:**	12
Module Leader	**:**	Mrs Karma Kezang Eudon
Module Tutor	**:**	Mr. Purna Bahadur Samal

General objectives or aims of the module:

This module will familiarize students with pn junction diode and Zener diode and introduce student the static characteristics of transistors and FET. The module will enable students to design transformer coupled Class A and Class B power Amplifier.

Learning outcomes:

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

1 Analyze the characteristic of Pn junction diode and construct the half and full wave rectifiers, Clipper and clamper circuit using pn junction diode.
2 Understand the basic concepts of transistors in CE, CB and CC configuration and analyse different biasing circuits
3 Design a single stage CE amplifier using data sheet of appropriate components.
4 Develop the characteristics of FET
5 Develop an understanding of amplifier circuits and be able to construct h-model and r-model equivalent circuits and find the voltage gain, current gain, and input and output impedance.
6 Design Power Amplifiers with less distortion
7 Use laboratory equipment, correctly and safely, to make measurements
8 Record and interpret the results of observed practical experiments

Learning and teaching approach used

Lectures introduce concepts and provide a broad background; local industrial visits are used to clarify particular points of detail or to illustrate concepts. Directed reading and assigned problems develop learning at a pace appropriate to the individual student. Tests and Tutorial sheets are used to help students to monitor their own progress through the module.

- Lecture : 3 hours per week
- Practical : 2 hour 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. **Semiconductor Theory:** Atomic Structure, Group III, IV, V Elements; Energy band theory, Fermi energy level; Heat developed in current carrying conductors and thermal conductivity of metals,
2. Intrinsic and extrinsic semiconductors, Drift and diffusion currents.
3. **P N Junction Diodes:** Formation of PN Junction; Characteristics of PN Junction diodes; Half wave and full wave rectifiers, Ripple factor, rectification efficiency, filters; Interpretation of Data Sheet for Diodes; Zener diodes, its characteristics & use as a simple voltage regulator; Clippers, Clampers, Peak detectors; General idea about LED, Photodiodes, Schottky diodes
4. **BJT Transistors:** Bipolar transistors, symbols and basic construction; Amplification action; Transistor currents; CE, CB & CC configurations & corresponding characteristics; BJT as a switch.; Analysis of biasing circuits; Stability factor, Thermal stabilisation and run away; h-parameter and remodel equivalent circuits; Small signal analysis of transistor amplifiers; Amplification, derivation of expressions for voltage gain, current gain, input and output impedance of CC, CB and CE configuration, with more focus on CE configuration; Design of a single stage CE amplifiers using data sheet of appropriate components; General idea about FET and MOSFET with characteristics
5. Silicon wafer fabrication, Different techniques involved in VLSI Technology.
6. **Power amplifiers:** Classification of Power amplifier; Distortion; Description of RC coupled and transformer coupled and direct coupled amplifiers; Class A and Class B type amplifiers both transformers coupled and transformer less.

List of Practical's:

1. To plot characteristics of pn junction diode
2. Application of diode in Clipper and Clamper Circuits
3. Construction of Rectifiers with Filters
4. Study Characteristics Zener diode and its application as voltage regulator
5. Characteristics of bipolar junction Transistor
6. Construction of Single stage amplifier and its analysis
7. Analysis of Cross Over Distortion in Power amplifiers
8. Efficiency of Power amplifiers – Class A or Class B .

Reading List

1. Jacob Millman and Christos C Halkias (2003), "Integrated Electronics, Analog and Digital circuits and Systems", Tata McGraw Hill, New Delhi.
2. Malvino (1999), "Electronics Principles", 6th edition, Tata McGraw Hill, New Delhi.
3. Robert L Boyelstad and Louis Nashelsky (2004), "Electronics Devices and Circuit Theory", 6th edition, PHI, New Delhi.
4. Muhammad H Rashid (1995), "Microelectronic Circuits : Analysis and Design", PWS Publishing Company.

5. Ramakant A Gayakwad (2002), “Op-Amp and Linear Integrated Circuits”, 4th edition, Pearson Education Asia.

Date: 3 June 2011

Name of the Module	**:**	Hydraulics and Hydraulic Machines
Module Code	**:**	FMH202
Semester	**:**	III
Credit Value	**:**	12
Module Leader	**:**	Mr. Om Kafley
Module Tutor	**:**	Mr. Om Kafley and Mr Ugyen Dorji

General Objective or Aim of the Module:

The aim of the module is to introduce the electrical engineering students to the fundamentals of hydraulics in applying their mathematical knowledge to static and dynamic fluid systems to solve the practical problems.

Learning Outcomes:

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

1. Calculate the forces that act on submerged planes and curves.
2. Apply the integral forms of the three fundamental laws of fluid mechanics to turbulent and laminar fluid flow through pipes and ducts in order to predict relevant pressures, velocities, and forces.
3. Draw simple hydraulic and energy grade lines.
4. Identify flow types in closed conduit and open channel flow.
5. Explain the working principles of hydraulic machines with special reference to Pelton, Kaplan, Francis turbines and Reciprocating and Centrifugal pumps.

Learning and Teaching Approach Used:

Mostly by lecture, but students are expected to support the module by reading from some of the suggested texts. The particular texts normally chosen to be appropriate to students own interest and background study. 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 per week
- Tutorial : 1 hour per week
- Self study : 6 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%.

Pre-requisite: Engineering Mechanics

Subject Matter:

1. **Properties of Fluids**: Development of fluid mechanics – Definition of fluid – Mass density – Specific weight – Specific gravity – Viscosity – Newton's law of viscosity - Compressibility and elasticity – Vapor pressure – Surface tension – Capillarity.
2. **Pressure Measurement**: Pressure – Pascal's law – Pressure variation with depth of liquid – Atmospheric pressure – Absolute pressure – Gauge and vacuum pressure – Measurement of atmospheric pressure and gauge pressure – Manometers – Differential – Inverted and micro manometers – Mechanical gauges.
3. **Hydrostatics**: Hydrostatic pressure on horizontal plane and vertical plane – Centre of pressure – Pressure diagram – Hydrostatic pressure on inclined plane and curved surfaces.
4. **Fluid Kinematics**: Lagrangian and Eulerian methods – Stream lines and Stream tubes – Laminar and turbulent flow – Uniform and non-uniform flow – Compressible and incompressible flow – Ideal and real fluids – Rotational and Irrotational flow – One-dimensional – Two-dimensional and three-dimensional flow – Continuity equation.
5. **Fluid Dynamics**: Forces acting on fluid in motion – Euler's equations of motion – Datum energy – Pressure energy and potential energy of fluid flow – Bernoulli's theorem – Momentum equation and their application.
6. **Flow Measurement:** Pitot tube and venturimeter – Orifices & external cylindrical mouthpieces – Rectangular and triangular notches/weirs.
7. **Flow through Pipes:** Hydraulic gradient and total energy lines – Laminar and turbulent flow – Major losses and minor losses – Darcy-Weisbach formula – Friction coefficient – Water hammer – Transmission of power through pipes – Flow through nozzle at the end of the pipe – Maximum power available and diameter of nozzle for transmitting maximum power – Water hammer in pipes.
8. **Impact of Free Jets:** Force exerted by fluid jet on: stationary flat plate, moving plate, stationary curved vane and moving curved vane.
9. **Hydraulic Turbines:** Classification of various turbines – Constructional details of Pelton wheel, Francis and Kaplan turbines – Velocity diagram and efficiencies – Draft tubes – Specific speed.
10. **Reciprocating Pumps:** Components and working – Different types – Work done by reciprocating pump – Air vessels – Multi-cylinder pumps.
11. **Centrifugal Pumps:** Components and working – Different types – Work done by the impeller – Head, losses and efficiencies – Minimum starting speed – Specific speed – Multi-stage pumps – Pumps in parallel – Performance of pumps – Priming – Centrifugal pumps troubles and remedies.

Reading Lists:

1. Modi, P.N. and Seth, S.M. (2002), "Hydraulics and Fluid Mechanics", 14th edition, Standard Book, New Delhi.
2. Jain, A.K. (2004). "A Text Book of Fluid Mechanics", 9th edition, Khanna Publisher, New Delhi.
3. Khurmi, R. S, (1988). "A Text Book on Hydraulics", 16th edition, S Chand & Company, New Delhi.

4. Jagdish, L. (2002), “Fluid Mechanics & Hydraulics”, Metropolitan Book Co, New Delhi.
5. Asawa, G.L., (1987), “Experimental Fluid Mechanics (volume 1)”, 3rd edition, Nem Chand & Bros, Roorkee.
6. Rajput, R.K., (2002), “Fluid Mechanics and Hydraulic Machines”, 2nd edition, S Chand & Company, New Delhi.
7. Subramanya, K., (2001). “Theory and Application of Fluid Mechanics”, 7th edition, Tata Mc Graw Hill, New Delhi.
8. Likhi, S. K., (2001), “Hydraulics Lab Manual”, New Age International, New Delhi.
9. Narayana, P. and Ramakrishna, C. R., (2003), “Principles of Fluid Mechanics & Hydraulics”, 1st edition, Universities Press, Hyderabad.
10. Lewitt, E.H., “Hydraulics and Mechanics of Fluids”, Pitman, New Delhi.
11. Streeter, V.L., (1983), “Fluid Mechanics”, 1st edition, McGraw Hill, New Delhi.
12. Vennard, J.K., (1940), “Elementary Fluid Mechanics”, 6th edition, John Wiley, New Delhi.
13. Garde, R.J and Gaoker, M., (1983), “Engineering Fluid Mechanics (including Hydraulic
14. Machine)”, 2nd edition, Nem Chand &Bros, Roorkee.
15. Ramadurgaiah, D., (2002), “Fluid Mechanics and Machinery”, New Age International, New Delhi.
16. Sarkar, B. K., (1999), “Fluid Mechanics and Hydraulic Machines”, Allied Publisher Ltd, New Delhi.
17. Kumar, K. L., (1976), “Engineering Fluid Mechanics”, 1st edition, Eurasia Publishing House, New Delhi.
18. Govida Rao, N.S., (1976), “Mechanics of Fluid”, Orient Longman, New Delhi.
19. Gupta, V. and Gupta, S.K., (1996), “Fluid Mechanics & its Application”, New Age
20. International, New Delhi.
21. Evett Jack B & Liu Cheng (1989), “Fluid Mechanics and Hydraulic”, McGraw Hill Book
22. Company.
23. Ranga Raju, K.G., (1993), “Flow through Open Channel”, 2nd edition, Tata McGraw Hill, New Delhi.
24. Jagdish, L., (2003), “Hydraulics Machines including Fluidics”, 6th edition, Metropolitan Book Co, New Delhi.

Date: 3 June 2011.

Semester IV

Name of the Module	**:**	Engineering Mathematics-IV
Module Code	**:**	MAT205
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
- Self Directed Learning : 6 hrs/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: 3 June 2011

Name of the Module	**:**	Electrical Machine -I
Module Code	**:**	EMC201
Semester	**:**	IV
Credit Value	:	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mr. Cheku Dorji

General objectives or aims of the module:

The module will introduce the basic theoretical practical concepts of D.C,machines and their applications and develop the basic concepts on the constructional details, working, testing and the application of transformers.

Learning outcomes:

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

1. Explain the principles of Electro-mechanical Torque
2. Derive EMF generated in full pitch, short pitch winding
3. Derive torque in terms of flux and MMF.
4. Describe armature windings - simplex lap and wave windings
5. Explain interaction of the fields produced by excitation circuit and armature, effects of brush shift, compensating winding.
6. Explain the methods of excitation and characteristics of D.C. generator
7. Explain the methods of excitation, characteristics, effects of armature and field resistances of D.C. motors
8. States the power stages, estimates different losses and efficiency.
9. Explain the basic working of Cross-field Machines
10. Examine various connections and their comparative features of three-phase transformers.
11. Explain harmonics in EMF and magnetizing current, effect of connections and construction on harmonics.
12. Perform parallel operation of single phase and three phase transformers and study load sharing.
13. Compare with two winding transformer and state the applications.
14. State the need of suitable Linear transformations in electrical machines.
15. Enlist the usual constraints on the choice of transformations of voltages and currents,
16. Explain power invariancy.
17. Explain the transformation of impedances.
18. Analyse physical interpretation.

Learning and teaching approach used

Most commonly chalk and talk method is used. OHP transparencies, pre-prepared handouts, practical demonstrations, personal interactions etc supplement this method of teaching.

- Lectures : 3 hours per week

- Tutorial : 1 hour per week
- Laboratory practical : 2 hours per week
- Self study : 7 hours per week

Workshop practical's as and when required and possible for demonstrations

Assessment

Regular questioning, phase tests class test, assignments, practical report, and terminal examinations for both theory and practical.

- **Theory – 75 marks**

Continuous assessment – 25 marks

1. Assignment – 15 marks
2. Midterm test, closed book – 10 marks

Semester End Examination 50 - marks

1. Written examination (closed book, 3 hours) – 50 marks

- **Practical Continuous Assessment – 25 marks**

1. Regular Laboratory assessment – 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. **Principles of Electro-mechanical Torque:** Basic concepts of torque production; Constructional features of rotating machines; Generated EMF in full pitch, short pitch; MMF of simple and multiple coils carrying currents; Harmonic analysis of induced voltage; Torque in terms of flux and MMF.
2. **D.C. Machines:** Armature windings - simplex lap and wave windings; EMF and torque equations; Interaction of the fields produced by excitation circuit and armature, effects of brush shift, compensating winding; D.C. generator - methods of excitation, characteristics; D.C. motors - methods of excitation, characteristics, effects of armature and field resistances; Commutation - causes of bad commutation, methods of improving commutation; Efficiency and losses - different losses and their estimation.
3. **Cross-field Machines**: Introduction and Principle of working *dqo* axes field, generator principles: matadyne, amplidyne, regulex- applications)
4. **Transformers:** Review of single phase transformers - theory and performance; Three-phase transformers - various connections and their comparative features; Harmonics in EMF and magnetizing current, effect of connections and construction on harmonics; Parallel operation of single phase and three phase transformers, sharing of load; Phase conversion 3-phase to 2-phase, and 3-phase to 6-phase transformation; Autotransformers-principle and comparison with two winding transformer, applications.

List of Practical's:

1. Determine open circuit and external characteristics of dc generator
2. Perform speed control of dc motor
3. Perform brake test on DC machine
4. Perform retardation test on dc machine
5. Perform Hopkinson test on DC machine
6. Perform OC & SC test on single-phase transformer
7. Perform load test on single-phase transformer and compute voltage regulation and efficiency.
8. Determine (Separation) the various losses of a single-phase transformer

Demonstration:

9. Perform Sumpner's test on single-phase transformer
10. Illustrate Scott connection of single-phase transformers

Reading List:

1. Theraja, B. L (2004), "Electrical Machines", S Chand and Company Ltd. New Delhi.
2. Nagrath and Kothari (2001), "Electrical Machines", The McGraw-Hill, New Delhi.
3. P.S. Bhimbra (2004), "Generalized Theory of Electrical Machines", Khanna Publishers, New Delhi.
4. P.S. Bhimbra (2005), "Electrical Machinery", Khanna Publishers, New Delhi.

Date: 3 June 2011

Name of the Module	**:**	Electronics-II
Module Code	**:**	ELE202
Semester	:	IV
Credit Value	**:**	12
Module Leader	**:**	Mrs. Karma Kesang Eudon
Module Tutor	**:**	Mrs. Karma Kesang Eudon and Mr Purna Samal

General objectives or aims of the module:

This module will familiarize students with the Multistage Amplifier, feedback Amplifier and introduce student the operational Amplifier and its applications. The module will enable students to analyse and design different Oscillator circuits.

Learning outcomes:

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

1. Design two stage amplifiers.
2. Analyze the feedback effect in amplifiers.
3. Use operational amplifiers in different applications like integrators, differentiators, wave generators etc
4. Identify the working and applications of current mirror field.
5. Analyze and design different oscillators.
6. Analyze transistor and IC voltage regulators.
7. Use laboratory equipment, correctly and safely, to make measurements
8. Record and interpret the results of observed practical experiments

Learning and teaching approach used

Lectures introduce concepts and provide a broad background; local industrial visits are used to clarify particular points of detail or to illustrate concepts. Directed reading and assigned problems develop learning at a pace appropriate to the individual student. Tests and Tutorial sheets are used to help students to monitor their own progress through the module.

- Lecture : 3 hours per week
- Practical : 2 hours per week
- Self study : 7 hours per week

Assessment

- **Theory – 75 marks**

Continuous assessment – 25 marks

1. Assignment – 15 marks
2. Midterm test, closed book – 10 marks

Semester End Examination 50 - marks

1. Written examination (closed book, 3 hours) – 50 marks

- **Practical Continuous Assessment – 25 marks**

1. Regular Laboratory assessment – 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%.

Pre-requisite knowledge: Electronics-I

Subject matter

1. **Multistage Amplifiers:** Introduction; Cascading; Darlington pairs and DC amplifiers; Low and High frequency analysis of BJTs; Frequency response and bode plots; Miller effects; Low and high frequency compensation; Tuned and wide band amplifiers; Design of two stage RC coupled amplifier
2. **Feedback Amplifier:** General idea of feedback, negative and positive feed back; Effects of negative feedback in amplifiers; Feedback Topologies and its effects on input impedance, output impedance, voltage gain, current gain and bandwidth
3. **Operational Amplifier and Applications:** Introduction; Performance characteristics of operational amplifier (ideal and non-ideal); Applications - Integrator, differentiator, summer, active and passive filter, comparators; Waveform generators
4. **Oscillators:** Positive feedback and conditions for Oscillation; Analysis and design of RC and LC oscillators (RC phase shift, Wein bridge, Colpitts and Hartley Oscillators); Crystal Oscillators. Timmer ICs (555) and applications; Phase Locked Loop.
5. **Voltage Regulators:** Analysis of Zener, Series and shunt type voltage regulators; IC regulators, OL and SC protection
6. **Current Mirrors:** Introduction; Simple (basic) current mirror, working and applications

Practicals:

1. Design and analysis of two stage RC coupled amplifiers
2. Analyze the effect of feedback in amplifiers
3. Applications of Op amp as Inverting & Non Inverting amplifiers
4. Application of Op Amp as Adder and Subtractor
5. Design and analysis of an RC Phase shift oscillator
6. Design and test series voltage regulators using regulator ICs
7. Design and test a current mirror using BJT

Reading List

1. Jacob Millman and Christos C Halkias (2003), "Integrated Electronics, Analog and Digital circuits and Systems", Tata McGraw Hill, New Delhi
2. Jacob Millman and Arvin Grabel, "Microelectronics", McGraw Hill International Edn
3. Robert L Boyelstad and Louis Nashelsky (2001), "Electronics Devices and Circuit Theory", 6th edition, PHI, New Delhi.
4. Muhammad H Rashid (1999), "Microelectronic Circuits: Analysis and Design", 1st edition, PWS Publishing Company, Boston.

5. Ramakant A Gayakwad (2002), "Op-Amp and Linear Integrated Circuits", 4th edition, Pearson Education Asia, Singapore.
6. Malvino (1999), "Electronics Principles", 6th edition, Tata McGraw Hill, New Delhi.

Date: 3 June 2011

Name of the Module	**:**	Applied Instrumentation
Module Code	**:**	EMI202
Semester	**:**	IV
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mr. Sonam Norbu

General objectives or aims of the module:

This module will familiarize students with the topics in Applied Instrumentation, which are essential for electrical engineering graduate at BE level. The module will develop the student's abilities to solve numericals in applied Instrumentation using their acquired knowledge and understanding of the electronic and digital electronic instruments.

Learning outcomes:

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

1. Understand the organization of instrumentation systems including telemetry systems, which is under engineering or already implemented, with their key elements
2. Give an example of transducers for measuring a particular physical parameter
3. Measure power, time, frequency and phase angle using electronic meters.
4. Discuss the basic concepts of spectrum analysis and the types of wave analyzers

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.. Directed reading and assigned problems develop learning at a pace appropriate to the individual student. Tests are used to help students to monitor their own progress through the module. Library assignments and group discussions are also given for enhancing the understanding of specific topics.

- Lecture : 3 hours per week
- Practical : 2 hours per week
- Self study : 7 hours per week

Assessment

- **Theory – 75 marks**

Continuous assessment - 25 marks

1. Assignment	-	10 marks.
2. Class tests: closed book	-	5 marks

3. Closed book midterm test - 10 marks.

Semester End Examination – 50 marks

1. Written examination: closed book, 3hrs - 70 marks.

- **Practical Continuous assessment - 25 marks**

1. Regular work: 15 marks as shown in annexure - I
2. Test/Viva – 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%.

Pre-requisite knowledge : Electrical Measuring Instruments

Subject matter

1. **Introduction:** Purposes of instrumentation and control systems, and their key functional elements; graphical representation of instrumentation and control systems
2. **Transducers:** Terminology and definitions; Signal Conditioning and Processing; Electrical transducers for non-electrical quantities like length, displacement, velocity, acceleration force, torque, level, pressure, temperature, flow, sound, light, humidity, and pH; Pneumatic transducers for pressure, level temperature and flow.
3. **Controllers and Telemetry:** Principles, basic components; general organization and structures of instrumentation and control system; Communication links; Human Machine Interface
4. **End Devices:** Indicators, recorders and annunciators; Final control elements - electrical and electro-pneumatic.
5. **Electronic Power Meters:** Classification of Electronic Power Instruments for audio, radio and micro wave frequencies; Multiplier type and Square law based electronic wattmeter; Calorimetric and Bolometric power meters; Power measurement by CRO.
6. **Instruments for Measuring Time, Frequency & Phase Angle:** Time Measurement - Timing Marker, Analog electronic time interval meters; Frequency Measurement - CRO method, Heterodyne method; AC bridges for frequency measurement; Wavemeter, analog electronic frequency meter; Phase Angle Measurement - CRO methods using single trace and dual trace CROs; Direct reading phase angle meter.
7. **Analysers :** Wave analysers - Frequency Selective Wave Analyser and Heterodyne Wave Analyser.; Harmonic Distortion Analyser and Meter - Concept of Harmonic Distortion, Tuned circuit Harmonic Analyser, Heterodyne Harmonic distortion meter; Spectrum Analyser - Basic concept of Spectrum Analysis, Heterodyne type Spectrum Analyser; Constraints for Sweep- voltage, bandwidth and sweep speed.
8. **Digital Electronic Instruments:** Digital counter timer, Digital Frequency meter; Digital Voltmeters, Digital Multimeter; Comparison of Analog and Digital Instruments; Accuracy consideration in digital counter-timers and digital voltmeters.

List of Practicals:

1. Measurement of ratio and phase angle errors of instrument transformers using comparison method and absolute method
2. Study and use of integrating type and dual-slop type electronics voltmeter

3. Spectrum analyser and its use for analysing frequency spectra of periodic and non periodic signals
4. Electronic Power Meter
5. (Calibration of Energy Meter: making up the leftover of E32 EMI, the module of the last semester)
6. Study and use of LVDT or another displacement transducer
7. Study of Characteristics of RTD
8. Study characteristics of Thermocouples
9. Study characteristics of Phototransistors, Photodiodes, LDR
10. Study and use of signal conditioners or convertors

If time permits, perform the following practical (sets available with Dynalog and Anshuman kits)

11. [Experiment on dynamic response of temperature transducers: in T/C]
12. Experiment on liquid level measurement
13. [Experiment on strain gage: in other practicals]
14. Experiment on a controller output transduce

Reading list

1. C.S. Rangan, C.R. Sharma and V.S. Mani, "Instrumentation Devices and Systems", Tata McGraw Hill Pub. Co.Ltd. New Delhi.
2. E.W. Deebelin (1990), "Measurement Systems: Applications and Design", 4th edition, McGraw Hill Book Co, Singapore.
3. H.N. Norton, "Handbook of Transducers for Electronic Measuring System", Prentice Hall Inc., Englewood Cliffs, New Jersey.
4. E.L. Gruenberg, "Handbook of Remote Control and Telemetry", McGraw Hill Book Co., New York.
5. W.D. Cooper and A.D. Helfrick (1990), "Electronic Instrumentation and Measurement Techniques", Prentice Hall of India Pvt. Ltd., New Delhi.
6. Singh S.K. (2006), "Industrial Instrumentation and Control", Tata McGraw Hill, New Delhi.
7. Golding E W (1979), "Electrical Measurements and measuring instruments", A W Wheeler and Company Pvt. Ltd., New Delhi.
8. W.D. Cooper and A.D. Helfrick, "Electronic Instrumentation and Measurement Techniques", Prentice Hall of India Pvt. Ltd., New Delhi.
9. B.M. Oliver and J.M. Cage, "Electronic Measurement and Instrumentation", McGraw Hill Koga Kusha Ltd.
10. A.C.J. Beerens, "Measuring Methods and Devices in Electronics", Haydess Book Co. Inc, New York.

Date: 3 June 2011

Name of the Module	**:**	Circuit Theory-II
Module Code	**:**	CKT202
Semester	**:**	IV
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Dr. Martin Pavlovsky

General objectives or aims of the module:

This module will familiarize students with the terminal conditions of networks that make each of the analysis procedures significant and will enable students analyze networks at different operating conditions. It will make students enable to visualize network stability. It will introduce students to the computer aided analysis and elementary synthesis techniques.

Learning outcomes:

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

11 Represent Physical systems in mathematical (differential equation) forms.

12 Use Laplace transform method as a tool for network analysis.

13 Calculate time domain response of different circuits at diverse initial conditions.

14 Characterize driving point and transfer functions of different forms of 2-port networks.

15 Differentiate between two port network parameters.

16 Represent a complex networks as two or more 2-port networks connected in series, parallel, or tandem connections.

17 Write a PSpice text editor file for describing a circuit to the PSpice simulation and analysis process.

18 Examine mathematical functions for Hurwitz polynomial test.

19 Examine driving point functions for positive realness.

20 Use Cauer and Foster forms of network synthesis.

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. 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.

- Lectures : 3 hours per week
- Tutorial and Computer based simulation session : 1 hour per week
- Self study : 6 hours per week

Assessment

- **Continuous assessment - 30 marks**
  1. Mid Term Test (One test, 10 marks)
  2. Assignment (Three assignments, 15 marks)
  3. Quiz (Five Test, 5 marks)
- **Semester End Examination (70 marks)**
  1. Written examination (One test of three hours duration, 70 marks)

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

Subject matter:

1. **Continuous Time Signals and Systems:** Basic continuous time signals, Unit step, ramp and impulse functions; Differential equation formulation for linear time invariant (LTI) continuous time systems.
2. **Time Domain Analysis:** Transient and steady state response of networks for different excitations (step, ramp, exponential, sinusoidal, impulse and damped functions); Review of Laplace Transform, Incorporating initial conditions; Initial and final value theorems; Concepts of transform impedance.
3. **Two port Networks:** Driving point and transfer functions; Characterization of multi port networks by driving point and transfer impedance & admittances; Generalized representation of loop and nodal analysis; Characterization of two port networks by different parameters; Relations among different parameters; Series, parallel and tandem connections of two port networks.
4. **Frequency Domain Analysis:** Concept of poles and zeros, pole locations and system stability; Frequency response and bode plots, Interrelation between frequency response and time response, Convolution integral.
5. **Computer Aided Analysis of Networks:** Computer aided D.C and A.C. analysis of linear networks (Introduction to PSpice); Introduction to transient analysis.
6. **Elementary Synthesis Techniques:** Positive real functions and their properties; tests for positive real functions; Driving point functions as positive real functions; synthesis of one port RC, RL & LC networks by Foster and Cauer forms.

Reading list

1. M.E. Van-Valkenberg (2002), “Network Analysis”, 3rd edition, Prentice Hall of India Ltd., New Delhi.
2. D. Roy Choudhury (2002), “Networks and Systems”, 1st edition, New Age International Pvt. Ltd. publishers, New Delhi.

3. J.A. Edminister (1996), "Electric Circuits", 1st edition, Tata Mc Graw Hill Publishing Company, New Delhi.
4. M.E. Van-Valkenberg (1994), "Introduction to Modern Network Synthesis", 1st edition, Wiley Eastern Ltd., New Delhi.
5. F.F. Kuo (2005), "Network Analysis and Synthesis", 2nd edition, John Wiley & sons, New York.
6. D. Chattopadhyay and P.C. Rakshit (2004), "Fundamentals of Electric Circuit Theory", 6th edition, S. Chand & Company Ltd. New Delhi.
7. P. W. Tuinenga (1988), "SPICE -A guide to Circuit Simulation and Analysis using PSpice", 1st edition, Prentice Hall Ltd. New Jersey.

Date: 3 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
- Self study : 4 hours per week

Assessment

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

4. Assignment - 10marks
5. Closed book mid Term Test- 15marks
6. Class Test - 5marks

Semester End Examination - 70marks (70%)

6. 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%.

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 Economics", 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: 3 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
Self study	:	6 hours 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: 3 June 2011

Name of the Module	**:**	Electromagnetic Field Theory
Module Code	**:**	EFT301
Semester	:	V
Credit Value	**:**	9
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Dr. Kazuhiro

General objectives or aims of the module:

This module will familiarize students with the concept of electrostatic and magnetic fields and their applications and introduce student the theory of propagation of waves.

Learning outcomes:

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

1. Calculate electrostatic energy and potential.
2. Analyse multi conductor systems.
3. Apply Laplace and Poisson's equations in different applications.
4. Analyse Magnetic boundary conditions and calculate energy stored in magnetic field.
5. Apply Maxwell's equations to wave propagation and penetration of electromagnetic field in different medium.
6. Examine wave propagation in free space and dielectric and discuss reflection and refraction of plane waves.

Learning and teaching approach used

Lectures introduce concepts and provide a broad background; local industrial visits are used to clarify particular points of detail or to illustrate concepts. Directed reading and assigned problems develop learning at a pace appropriate to the individual student. Tests and Tutorial sheets are used to help students to monitor their own progress through the module.

- Lecture : 3 hours per week
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment

- **Continuous assessment - 30 marks**

1. Assignment - 10 marks.
2. Class tests: closed book - 10 marks
3. Mid-Sem Test: closed book – 10 marks.

Semester End Examination - 70 marks

1. 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%.

Subject matter

1. **Electrostatic fields:** Coulomb's law, Electric field intensity, Flux density D, Gauss law and examples to illustrate Divergence theorem, Work done in electrostatic field in moving a unit positive charge, Definition of electric potential, Electric dipole, Potential and electric field at a point due to electric dipole, Boundary conditions, method of images, Laplace and Poisson's equations, Uniqueness theorem, Examples of solution of Laplace's and Poisson's equation, Electrostatic energy, energy density, Definition of capacitance, Parallel plate, cylindrical and spherical capacitors, Capacitor with composite dielectric capacitance in multiconductor systems.
2. **Static Magnetic Fields:** Concept of a magnetic field, Ampere's law, Biot Savart's law, line integral of a magnetic field, Curl of a vector field, Stoke's theorem, Magnetic flux and flux density, magnetic field caused by different types of current

configurations, Scalar magnetic potential, concept of vector magnetic potential, Force on a differential current element, Force between differential current elements, Magnetic boundary conditions, Energy stored in magnetic field, inductance calculations.

3. **Maxwell's Equations:** Equation of continuity for time varying fields, displacement current, Maxwell's equations, Application of Maxwell's equation to wave propagation and penetration of electromagnetic fields into a good conductor, Poynting theorem for energy relation in an electromagnetic field.
4. **Wave Theorem:** Wave propagation in free space and dielectrics, Reflection and refraction of plane waves, Standing wave ratio, Wave polarization

Reading List:

1. John D. Kraus and KR Carver, "Electromagnetics", McGraw Hill, New York.
2. W.J. Hayt (2003), "Engineering Electromagnetics", 6th edition, Tata McGraw Hill, New Delhi.
3. E.C. Jordan (2005), "Electromagnetic waves and Radiatory Systems", 2nd edition, Prentice Hall of India, New Delhi.
4. Sadiku M.N.O., (2005), "Elements of Electromagnetism", 3rd edition, Oxford University Press, New York.
5. Edminister J.A., (2004), "Theory and Problems of Electromagnetics", 2nd edition, Tata McGraw Hill, New Delhi.

Date: 3 June 2011

Name of the Module	**:**	Electrical Machines-II
Module Code	**:**	EMC301
Semester	**:**	V
Credit Value	**:**	15
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mr. Cheku Dorji

General objectives or aims of the module:

To develop the basic concepts on the constructional details, working principle, testing procedure, controls, conceptual analysis to certain extent and the applications of the Poly-phase and single-phase induction machines; poly-phase commutator machines; and Synchronous machines and other special machines

Learning outcomes:

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

1. Describe working of poly phase machine from rotating field view point- constructional features.
2. Explain concept of leakage reactance and its importance on machine performance and design
3. Explain construction and working of double cage rotors
4. Explain space-harmonics and their effect on motor performance
5. Explain and use of starting methods: Principles of speed control - control of speed of rotating field - control of slip-speed and - Stator voltage control.
6. Use Kramer scheme of speed control of induction motors.
7. Explain the principle, working and characteristics of Repulsion motors and state applications
8. Explain single-phase induction motor; double revolving field theory, equivalent circuit and characteristics.
9. Explain single phase series motor-working and characteristics applications
10. Explain constructional features - salient pole and cylindrical rotor synchronous machines
11. Explain cooling systems of generators
12. Relate winding coefficients, harmonics in generated e.m.f., tooth ripples and armature reaction.
13. Apply d-q-o transformation
14. Examine operation under balanced steady state conditions - Equations in terms of voltage current phasors and direct and quadrature axis reactances
15. Derive power angle equations-wound rotor machine as a special case.
16. Analyse qualitatively synchronous generator operation subjected to sudden symmetrical short circuit
17. Analyse the effects of saturation on voltage regulation.
18. Construct V-curves, and phasor diagram.
19. Explain elementary ideas about stability and hunting.
20. Describe construction and working of Linear induction motors, Induction Generator, Schrage motor, Stepper motor, Reluctance motor and Hysterisis motor.

Learning and teaching approach used

Most commonly chalk and talk method is used. This supplemented by OHP transparencies, pre-prepared handouts, practical demonstrations, personal interactions etc

- Lectures : 4 hours per week
- Tutorial : 1 hour per week

- Laboratory practical : 3 hours per week
- Self study : 8 hours per week

Assessment

Regular questioning, phase tests class test, assignments, practical report, and terminal examinations for both theory and practical.

- **Theory – 75 marks**

Continuous assessment – 25 marks

1. Assignment – 15 marks
2. Midterm test, closed book – 10 marks

Semester End Examination - 50 marks

1. Written examination (closed book, 3 hours) – 50 marks

- **Practical Continuous Assessment – 25 marks**

1. Regular Laboratory assessment – 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. **Polyphase Induction Machines:** Qualitative description of working of poly phase machine from rotating field view point- constructional features; Operation under balanced supply voltage conditions, equivalent circuit, phasor diagram, current locus; Concept of leakage reactance and its importance on machine performance and design; Double cage rotors; Space-harmonics and their effect on motor performance; Principles of starting methods; Principles of speed control - control of speed of rotating field - control of slip-speed and - Stator voltage control.
2. **Polyhase A.C. Commutator Machines:** Effect of voltage injection in secondary of slip-ring induction motor, action of commutator as frequency converter; Kramer scheme of speed control of induction motors; Principle, working and characteristics of Repulsion motors and applications.
3. **Single-Phase Motors:** Single-phase induction motor, double revolving field theory, equivalent circuit and characteristics; Single phase series motor-working and characteristics applications
4. **General Description of Synchronous Machines:** Constructional features - salient pole and cylindrical rotor synchronous machines; Cooling systems of generators; Qualitative description of working of a synchronous generator; Generated e.m.f; Winding coefficients, harmonics in generated e.m.f., tooth ripples and armature reaction.
5. **Theory of Ideal Synchronous machines:** Coupled circuit model of an idealized salient pole machine; Application of d-q-o transformation; Operation under balanced steady state conditions - Equations in terms of voltage current phasors and direct and quadrature axis reactances; Power angle equations-wound rotor machine as a special case; Qualitative analysis of synchronous generator subjected to sudden symmetrical short circuit

6. **Voltage Regulation:** Voltage regulation of salient pole and cylindrical rotor synchronous machines; effects of saturation on voltage regulation.
7. **Synchronous Motors:** Steady state operating characteristics; V-curves, phasor diagram.
8. **Parallel Operation of Alternators:** Synchronizing and load division; Synchronous machine on infinite bus; Elementary ideas about stability and hunting.
9. **Special Machines**: Linear induction motors, Induction Generator, Schrage motor and Stepper motor; Reluctance motor and Hysterisis motor.
10. **Linear Transformations:** Need for suitable transformations; Usual constraints on the choice of transformations of voltages and currents; Power invariancy; Transformation of impedances; Definition of (α, β, O), (d,q,O) and symmetrical components transformations; Physical interpretation.

List of practicals:

1. Determine equivalent circuit of three phase induction motor
2. Perform brake test on three phase induction motor
3. Plot circle diagram of three phase induction motor
4. Perform speed control of three phase Induction motor
5. Determine regulation of three phase alternator by synchronous impedance method and AT method
6. Determine regulation of alternator by Z P F method
7. Perform parallel operation of alternators
8. Determine V and inverted V curves of three phase synchronous machines

Demonstration:

1. Examine single phase operation of three phase induction motor
2. Perform brake test on single phase induction motor
3. Separate losses of three phase induction motor
4. Determine regulation of three phase alternator by two reaction theory

Reading list

1. P.S. Bhimbra (2004), "Generalized Theory of Electrical Machines", Khanna Publishers, New Delhi.
2. P.S. Bhimbra (2005), "Electrical Machinery", Khanna Publishers, New Delhi.
3. A.E. Fitzgerald and C. Kingsley Jr (2002), "Electrical Machinery", 2nd edition, McGraw Hill, Koga Kusha, Tokyo.
4. A.S. Langsdorf (2001), "Theory of A.C. Machines", McGraw Hill, Koga Kusha, Tokyo.
5. M.G. Say (2002), "The Performance and Design of A.C. Machines", CBS, Delhi.
6. E. Openshaw Taylor, "The performance and design of A.C. Commutator Machines", Wheeler Publishing Co.
7. E.R. Laithwaite, M (2002), "Linear Electric Motors", Mills and Boon, London.
8. I.J. Nagrath, D. Kothari (2001), "Electric Machines", Tata McGraw Hill, New Delhi.

9. E.W. Kimbark (2004), "Power System Stability, Vol. III Synchronous Machines", John Wiley & Sons, New York.

Date: 3 June 2011

Name of the Module	**:**	Power Generation
Module Code	**:**	PSS301
Semester	**:**	V
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutors	**:**	Mr Roshan Chhetri

General objectives or aims of the module:

The module will enable students to understand the different sources of energy used for electric power generation, principles and components of power generation, generation planning, tariffs, power plant economics, power factor improvement and utilization of electric power.

Learning outcomes:

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

1. Classify both conventional and non-conventional methods of power generation.
2. Analyze qualitative knowledge of different types of power plants including site selection, working principle, general layout of power plants, environmental aspects, power generation, generation planning, power plant economics and tariffs.
3. Analyze short term and long term load forecasting.
4. Calculate cost of unit energy generation, fixed and variable (operating) costs, tariffs, load factor, maximum demand factor and diversity factor.
5. Analyze the basic concepts of reliability modeling of generating units, generation capacity reserve evaluation and reliability indices.
6. Explain the causes and effects of low power factor.
7. Explain the various methods of power factor improvement and calculate the most economic power factor.
8. Describe the utilization of power in illumination, electric welding, electric heating and electrolytic processes.
9. Carry out directed private study using textbooks, and other provided resources
10. Identify, formulate and organize engineering problems in a conceptual form as well as in terms of mathematical and physical models.

Learning and teaching approach used

- Lectures : 4 hours per week.
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment

- **Continuous Assessment - 30 marks**

1. Assignments (open books) : 10 marks
2. Class tests (closed books) : 10 marks
3. Mid-term test (closed books) : 10 marks

Semester End Examination – 70 marks

1. Semester End Examination (closed books, 3 hours) : 70 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%.

Pre-requisite : Circuit Theory – I, Circuit Theory – II, Electrical Machines-I

Subject matter

1. **Conventional sources:** Hydro station - Selection of site, classification of hydro power plants according to flow regulations, available head, power output and loading; principle of working, power developed, layout of a hydro station, underground power house; Steam Power plant - Introduction, Selection of site, general layout of a thermal power plant –fuel and ash circuit, air and flue gas circuit, feed water and steam circuit, cooling water circuit, boiler, super heater, economizer, electrostatic precipitator; Nuclear Power Plant:- Introduction, Nuclear reactors, location of nuclear power plants, classification of reactors based on type of fuel cycle, speed of fission process and type of coolant; Gas Turbine Plant: - Introduction, layout of a gas turbine power plant, advantages and disadvantages.
2. **Non-Conventional Sources:** Tidal power - introduction, basic schemes, turbines; Wind power - Introduction, Characteristics of wind power, factors influencing wind power development, design considerations for wind wheels; Geothermal Power - Introduction, Principle of operation, combined operation of geothermal plant; MHD generation - Introduction, Principle of operation of MHD generator, Open and close cycle MHD generation; Solar Energy- Introduction, Residential cooling and heating photosynthesis, production of energy sources-solar power plant, solar concentrator, flat plate collector.
3. **Generation Planning:** Criteria for generation planning, reliability and economy, reliability modelling of generating units, generating capacity reserve evaluation, reliability indices; Demand and Energy forecasts; Methods of forecasting: long term and short term forecasts, peak demand forecasts, weather and non weather sensitive forecasts, seasonal and annual forecast; Relationship between load forecasting and power system planning; Types of load, chronological load curves, load duration curve, energy load curve mass curve; Load factor, maximum demand, demand factor, diversity factor, utilisation factor, capacity factor, losses and their calculation; Objectives of tariffs, general tariffs form; Different types of tariffs, fixed and variable tariffs; Spot (time differentiated) pricing .
4. **Power Plant Economics:** Capital cost of plants, annual Fixed and variable costs; Methods of depreciation, operating costs, calculation of cost of unit energy generation; Effect of load factor on unit energy cost, role of low diversity in power system economics; Introduction to marginal cost approach to rate making; Causes and effects of low power factor; Economics of power factor improvement; Methods of

Power factor improvement; Calculation of most economic power factor when (a) kW demand is constant and (b) kVA demand is constant.

5. **Illumination:** Nature of light, definitions, units, basic laws of illumination; Roussece construction for determination of luminous flux; Light sources and their characteristics; Light production by excitation and ionisation; Incandescence and fluorescence, sources of light; Filament lamp, Halogen lamp, Discharge lamp, Fluorescent lamp, Arc lamp and their applications; Direct, diffused and mixed reflection, Reflection factor, Transmission factor, Refractors, Lighting fittings; Street lighting, Exterior lighting and interior lighting.

Reading lists:

1. C.L Wadhwa (2006), "Generation Distribution and Utilization of Electrical Energy", New Age International Publishers, New Delhi.
2. AK Raja, Amit Prakash Srivastava and Manish Dwivedi (2006), "Power Plant Engineering", New Age International Publishers, New Delhi.
3. B. R. Gupta (2002), "Generation of Electrical Energy", S. Chand and Company Limited, India.
4. A S Pabla, "Electrical Power Systems Planning", Mcmillan India Limited, New Delhi.
5. Soni, Gupta and Bhatnagar, "Electrical Power Systems", Dhanpat Roy and Sons Publishers, India.
6. J B Gupta (2003), "Utilisation of Electric Power and Electric Traction", S K Kataria and Sons, New Delhi.
7. S. Hasan Saeed and D.K. Sharma (2009), "Non-Conventional Energy Resources", S.K. Katarai & Sons, New Delhi.

Date: 3 June 2011

Name of the Module	**:**	Digital Electronics and Logic Design
Module Code	**:**	DEL301
Semester	**:**	V
Credit Value	**:**	9
Module Leader	**:**	Dr. Kazuhiro Muramatsu
Module Tutor	**:**	Dr. Kazuhiro Muramatsu and Ms. Sonam Peden

General objectives or aims of the module:

This module will familiarize students with the concept of Digital Electronics that is essential for Electrical Engineering at BE level. The module will develop basic analytical understanding of Digital Electronics in designing and implementation of Digital logic circuits and their applications in the field of Electrical Engineering.

Learning outcomes:

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

1. Identify different Logic Gates and their symbols
2. Compute and convert from a base 'n' number system to another base number system
3. Utilize the postulates and theorems of Boolean Algebra
4. Simplify Boolean expressions using Boolean Algebra and V-K maps
5. Implement Combinational Logic Circuits using SOP and POS design
6. Identify different Flip Flops and their symbols
7. Implement Sequential Logic Circuits using various flip Flops
8. Formulate logical problems involving combinational and Sequential digital design and organize solution Methodologies.

Learning and teaching approach used

- Lecture : 2 hours per week

- Tutorial and Practical : 2 hours per week (Tut & Prac alternate week)
- Self study : 4 hours per week

Assessment

- **Theory – 75 marks**

Continuous assessment – 25 marks

1. Assignment – 15 marks
2. Midterm test, closed book – 10 marks

Semester End Examination - 50 marks

1. Written examination (closed book, 3 hours) – 50 marks

- **Practical Continuous Assessment – 25 marks**

1. Regular Laboratory assessment – 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. **Number Systems:** Generalized representation of Numbers; 2s complement and (2-1)' complement representation of numbers; Representation of negative numbers.
2. **Boolean Algebra:** Postulates, theorems, use of Boolean algebra for simplification; Simplification of bolean expressions using Quine McClusky method and V-K maps.
3. **Logic Gates:** AND, OR NOT, NAND, NOR, EX-OR gates - their symbols, truth tables and I.C. versions, open collector; State devices, schmitt trigger, TTL and other logic, families.
4. **Flip-Flops:** Various types, truth tables, IC versions.
5. **Monostable Multivibrator:** Retriggerable and non-retriggerable types, IC versions.
6. **Astable Multivibrator:** Various types, synchronization, IC versions.
7. **Combination at Logic Circuits:** General circuit design; Digital multiplexers and demultiplexer; Encoders and decoders, adders and subtractors, IC versions.
8. **Sequential Circuits:** Basic concepts of design, counters, shift-registers and register operations, IC versions, bus-organised systems (basic concept using 3-state devices).
9. **D/A Converter:** Weighted resistor and ladder types D/A converters; Performance specifications, IC versions.
10. **A/D Converters:** Single slope, dual-slope successive approximation and other types of A/D converters; Performance specifications, IC versions.

List of practicals:

1. Practice on IC Trainer kit and Digi Board.
2. Verify their truth tables for Basic Logic gates using Digi Board and Digital ICs bread board trainer.
3. Construct R-S Flip-flop using NAND Gate and verify its truth tables using Digi Board or Digital ICs.

4. Construct Clocked R-S Flip-flop using NAND Gate and verify its truth tables using Digi Board or Digital ICs.
5. Verify its truth tables for JK Flip Flops using Digi Board or Digital ICs.
6. Construct half and Full adders using basic logic gates and digital LSI chips.
7. Study Digital to Analog converters using R-2R ladder.
8. Implement a three-bit ripple counter and verify its output using three J-K Flip-flops.

Reading list

1. M Morris Mano (2001), "Digital Logic and Computer design", 25th reprint, Prentice – Hall International Inc., New Delhi.
2. N.R. Scott, "Analog and Digital Computer Technology", McGraw Hill, New York.
3. A.P. Malvino and D. P. Leach (2003), "Digital Principle and application", Tata McGraw Hill, New Delhi.
4. Louis Nashelsky, "Introduction to Digital Computer Technology",
5. Roger L. Tokheim (1989), Digital Electronics – Third Edition, McGraw Hill, New York.
6. Gerald E Williams, "Digital Technology",

Date: **3 June 2011**

Semester VI

ཆོས་ཚན་མིང་།	རྫོང་ཁ། (Dzongkha)
ཆོས་ཚན་དོན་རྒྱས།	DZO301
སློབ་དུས།	༦ (6)
ས་ཚན།	༩ (9)
བཟོ་མི།	མཁོན་པོ་རྡོ་རྗེ། (Gembo Dorji)
སློབ་སྟོན་པ།	མཁོན་པོ་རྡོ་རྗེ། (Gembo Dorji)

དམིགས་ཡུལ།

རྫོང་ཁའི་དམིགས་ཡུལ་གཙོ་བོ་ནང་ སྐད་ཡིག་ཟུང་འབྲེལ་གྱི་ཐོག་ལས་ སྤིན་བྱས་དང་བཤུ་བ་ཚུ་ལག་ལེན་འཐབ་སྟེ་ཞིབས་ཏོག་ཁུ་འཚུག་ནི་དང་ནང་དོན་རིག་པའི་ཞུན་ཆོས་དང་རང་གི་ངོ་རྒྱས་སྟོན་ནི།

སློབ་སྦྱོང་བྱུབ་འབྲས།

1) སྐད་ཡིག་ཟུང་འབྲེལ་གྱི་ཐོག་ལུ་བཟོ་བཀོད་ཅ་ལའི་མིང་ཚིག་དང་ཞུ་ཚིག་བཏང་ཡིག་འབྲི་རྩོམ་གྱི་ཚིག་གི་སྒྲུབ་ཐབས་

ཚུ་ཤེས་ཏེ་སྐད་ཡིག་ཚད་ལྡན་གྱི་ངོ་རྟགས་སྟོན་ལས་སློབ་གཉེར་གི་ལས་སྡུ་ཚུ་ལུ་ལྟོགས་གྲུབ་ཅན་གྱིས་གདམ་ཁའི་འོས་འདེམས་ཚོང་ཚུགས་ཨིན།

༢) བསམ་སྤྱོད་ཤེས་ཡོན་ཚུ་གོང་འཕེལ་བཏང་སྟེ་ཁྱད་ཆོས་བཟང་ཞིའི་ལམ་སྲོལ་ཚུ་བདག་འཛིན་འབད་ཚུགས་མ་ཚད་མི་སྡེ་དཔལ་འབྱོར་གྱི་ཐོག་ལས་རང་མའོ་རངས་འདོད་སྤྲོད་ཚུགས་བཟོ་ནི།

སློབ་སྟོན་འབད་ཐངས།

༡) ཕྱད་དང་རྟམ་ཡིག་ཆོག་རྒྱུན་གྱི་ཐོག་སློབ་ཁ་ཚུ་དེའི་སྟོན་འབད་ཞིམ་གསལ་སྤེ་བཅའ་ཁྲིམས་ལྟ་བུ་ལས་འགྱལ་བྱིན་ཏེ་དབྱེ་ཞིབ་འབད་ནི།

༢) རྩོད་ཁའི་ཡིག་སྡེབ་འཛམ་ཀྱོད་ཀྱོད་གི་ཐོག་ལུ་ཅ་ཆས་ཀྱི་མིང་ཆོག་དོམ་འབད་ལག་ལེན་འཐབ་ནི།

༣) བྱི་སྤྲབ་ཤེས་གསུམ་སྦྱང་བ་ཐོབ་དོན་ལུ་སྤྱོད་བརྩ་པ་ཚུ་ཁོངས་རང་ནང་དོག་སྡེ་ཚན་གཅོག་ཏུ་ཕྱེས་བཅུག་ནི་དང་དཔེར་བརྩོད་ཀྱི་ཐོག་དབྱེ་ཞིབ་འབད་ནི།

༤) སྤྲོག་རི་འཕྱལ་ཆས་ལག་ལེན་འཐབ་སྟེ་དཔེ་རིའི་སྟོན་སྡུ་ཆོག་ཀྱི་ཐོག་ལུ་བཙུད་སྟོན་འབད་ནི།

༥) སྤྱི་ལས་རྩལ་གཞག་དང་སྡེབ་ཀྱི་སྤྱོར་ལས་དང་རིའི་ཐོག་ལུ་དང་དངོས་སུ་ལག་ལེན་འཐབ་ཐོག་ལས་སྟོན་ནི།

ཆོང་ཁའི་སྟོན་རིམ་དུས་ཚོད།

ཕྱི་སྤྱོང་ལུ་དུས་ཡུན་ཆུ་ཚོད་༡༥

ནང་སྤྱོང་ལུ༢

སྐྱབས་ཅིན་ཐངས།

སློབ་ཁང་ཁྲིམས་ལུ༡ ༧༥

སྟོན་རིམ་ཆོས་རྒྱུགས༡ ༧༥

སློབ་དུས་ཆོས་རྒྱུགས༡ ᳙᳐

དོན་ཚན།

༡) **གོང་རིམ་བརྟ་གཞུང་༡** (ལེའུ་ལྔ་པ) རང་དབང་རྒྱུ་ཐུབ་དྲན(ལེའུ་དྲུག་པ)སྟེ་ཚན་ཅན་ཀྱི་ཐབ་དྲུག)ལེའུ་བདུན་པ། ཡི་ཀུ་སྤྱོང་བའི་འབྲེལ་ཚོག་དེའི་ནང་ཁྱོད་ཆོག་དོན་སྤྱོང་ཐབས།བརྟེད་པ་བཟོ་ཐབས།ཞུ་ཚོག་བཏང་ཡིག་བའི་ཐབས།མིག་བས་ལ་ཁྱོད་ཆའི་མིང་ཚོག་ཡིག་སྟེབ་དང་བརྟ་བ་ཤེས་ཐབས་ལས།

๒) **སྐྱབས་འགྲོའི་ངོ་སྤྲོ།**མཐུན་མོང་། མཐུན་མིན། བསྟན་བྱའི་ཕན་ཡོན།ཉེས་དམིགས་སེམས་ཀྱི་བསྒྲིབ་ལྡུ་བ།ཉོན་མོངས་སྤྱག་གསུམ།ཞེ་སྡང་།འདོད་ཆགས།གཏི་མུག་བསམ་མཐའ་ཡས་སྐྱོར་བ།མངའ་ཐང་ཆེ་བ།

๓) **དགེ་མི་དགེ་ཕྱི་ཙམ་ཡང་དུག་ཐ།**རོ་བའི་ལྷི་བ།ལུས་ངག་གི་ལྷི་རྩུལ། རྣམ་སྨིན། རྒྱུ་མཐུན། བདག་འབྲས།བསྡུ་བ་བཞི།ལས་འབྲས། (ལེགས་བཤད་ ལུང་སྨྲའི་གོ་དོན།མཐས་པ་བརྟག་པ། ཟློག་པོ་བརྟག་པ། བྱ་བ་བརྟག་པ། ཆོས་བརྟག་རྩོལ་སྐོར།

๔) **སྐྱེ་ཁམ་རྣམ་གཞག་ཐ།**རང་གི་རྣམ་གཞག་ཐུཕྱི་ནི་རྣམ་གཞག་ཐེན་འབྲེལ་བཅོ་སྦྱང་ཞུ་ནི་སྐོར།

རྒྱབ་རྟེན་དུས་ཚ།

๑) རྩོད་བ་ལྷན་ཆོས་གྲྭ། 2008 *ཤོད་རིམ་བརྒྱ་གཞུང་།* རྩོད་བ་ལྷན་ཆོས་གྲྭ།

๒) འཇིགས་མེད་ཆོས་གྲགས། 2003 *རྒྱབས་བཟོད་བསམ་སྦྱོར་ཤེས་ཡོན།* ཆོས་ཟན་ལགཔ་ལེན་སྨིང་པོ།

๓) ནོར་དབང་དང་བདུད་འཛོམས་སྤྱལ་སྐུ། 1966 *རྒྱ་ཅོ་ལ།* རིག་ཚན་ཤུངཆོས།ཤར་བྱ་མི་རྟེ། བོད་མ་ཁས་བཀའ་ཟློར།

๔) འཇིགས་མེད་ཆོས་རྒྱལ། 2005 *ཐུབ་ཁུ་པའི་རྣམ་བཤད།* ཤེས་རབ་རྩེ་མཐོ་རིམ་སློབ་གྲྭ།

๕) རྒྱལ་གཅིམ་རྡོ་རྗེ་རྒྱལ་མཚན། 1999 *སྐྱེ་ཁམ་རྣམ་གཞག* ཞིམ་ཁུ།

๖) བྱང་སེམས་བཀྲིས། 2005 *དགའ་སྐྱིད་ཚལ་སྟོན་བྱེད་དུས་དགའ་བའི་རྒྱུན།* ཞིབ་འཇུག་ཕྱེ་བ།

๗) སྤྲོན་ཀུན་བཟང་འཕྲིན་ལས། 2005 *རྩོད་བའི་ཚོགས་མཆོད།* ཀ་ཛེམ་ཀྱི།

๘) དྲང་ཆེན་སངས་རྒྱས་རྡོ་རྗེ། 2002 *རྩོད་བའི་ཡིག་སྒྲུང་རྣམ་གཞག་རྩོད་ཁ་ལྷན་ཆོས་གྲྭ།*

๙) འཇམ་པ་ཆོས་གྲགས་པ། 2005 *ལས་སྟོན་བྱེད་དུག་བ་བའི་རྒྱུན།*

๑๐) དག་དབང་ཕྱག་རྡོར། 2005 *ལེགས་བཤད་ཕྱོགས་དབང་།* ཀ་ཛེམ་ཀྱི།

๑๑) མཁན་ཕུན་ཆོས་པཎྜིས། 2003 *བཅོ་རིག་ཀྱི་ཅེབ།*

སྤྱི་ལོ་2017དབྱིན་ཟླ ༤ ཐ།

Name of the Module	:	Environmental Science
Module code	:	EVS 301
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:

i. learn multidisciplinary nature of environment.
ii. synthesize different types of natural resources and thus be able to play an active role in conservation of it.
iii. analyze the impacts of environmental degradation on ecology and society.
iv. investigate different kinds of problems related to environment pollution.
v. explain the impacts of toxicity of certain heavy metals like arsenic, cadmium, lead, mercury, chromium, copper, zinc on health of living beings and environment.
vi. learn various kinds of disaster mitigation techniques.
vii. 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: 3 June 2011

Name of the Module	**:**	Signal and Systems
Module Code	**:**	SAS301
Semester	**:**	VI
Credit Value	**:**	9
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Dr. Jyun-jye Felipe Chen

General objectives or aims of the module:

This module will familiarize students with the basic representation and analysis. It focuses on continuous and discrete linear time invariant signals.

Learning outcomes:

At the end of the module, students are expected to be able to recognize the 4 different kinds of Fourier transforms and apply them to respective applications. They should be able to use Laplace and Fourier transform techniques to approach the solution of a specific engineering problem. Z transform should be clearly and strongly built into the minds of students who complete this course so that they can handle digital signal processing module.

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. 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.

- Lectures : 2 hours per week
- Tutoring : 2 hours per week
- Self study : 4 hours per week

Assessment:

- **Continuous assessment - 30 marks**

1. Mid Term Test (One test, 10 marks)
2. Assignment (Three assignments, 15 marks)
3. Computer based design simulation(One Test, 5 marks)

Semester End Examination - 70 marks

1. Written examination (One test of three hours duration, 70 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%.

Pre-requisite: Circuit Theory -II

Subject matters

1. **Dynamic Representation of Systems:** system attributes, causality linearity, stability, time-invariance, special signals, complex exponentials, singularity functions (impulse and step functions.)
2. **LTI Systems:** differential equation representation, convolution integral, discrete form of special functions, discrete convolution and its properties, realization of LTI system (differential and difference equations).
3. **Fourier Analysis of continuous Time signals and Systems:** Fourier series, Fourier transform and properties, Parseval's theorem, frequency response of LTI systems, sampling theorem.

4. **Fourier Analysis of Discrete Time Signals and Systems:** discrete-time Fourier series, discrete time Fourier transform and properties, frequency response of discrete time LTI systems.
5. **Laplace transform:** Laplace transform and its inverse, definition, existence conditions, region of convergence and properties, application of Laplace transform for the analysis of continuous time LTI system (stability etc.), significance of poles and zeros.
6. **Z-transform:** z transform and its inverse, definition, existence conditions, region of convergence and properties, application of z transform for the analysis of discrete time LTI system (stability etc.), significance of poles and zeros.
7. **Introduction to random signals:** Introduction to probability, Normal/ Binomial/ Poisson distributions, concept of random variable, probability density and distribution functions, function of a random variable, moments, independence of a random variable, introduction to random process, auto and cross correlation, power spectral density.

Reading list

1. A.V. Oppenheim, A.S. Willsky and H. Nawab (2000), "Signals and Systems", Prentice Hall, India.
2. Simon Haykin (2001), "Signals and Systems", John Wiley and Sons Inc., New York.
3. Erwin Kreyszig, (2006), "Advanced Engineering Mathematics", 9th edition, Wiley.

Date: 1st August, 2010

Name of the Module	**:**	Power Electronics
Module Code	**:**	ELE301
Semester	**:**	VI
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri

Module Tutor **:** Dr. Sonam Norbu

General objectives or aims of the module:

This module will introduce the concept of power electronics essential for basic electrical engineering and facilitate students with concept of working principle of ac-dc, dc-dc, dc-ac and ac-ac converters.

Learning outcomes:

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

1. Identify various semiconductor devices and their V-I characteristics.
2. Distinguish and describe the operation of passive and active rectifiers.
3. Recognise dc-dc converters in various configurations and describe their relevant properties.
4. Analyse and describe operation of various dc-ac and ac-ac converters.

Learning and teaching approach used

- Lectures : 3 hours per week
- Laboratory practical : 2 hours per week
- Self study : 6 hours per week

Assessment

- **Theory – 75 marks**

Continuous assessment - 25 marks

1. Assignment: 7 marks
2. Class Tests: 18 marks (2 tests 9 marks each)

Semester End Examination - 50 marks

1. Written examination: closed book, 50 marks, 3 hrs

- **Continuous assessment practical - 25 marks**

1. Regular Laboratory assessment - 15 marks (1.5 mark per report from an experiment)
2. Test/Viva - 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. **Introduction:** Concept of power electronics, scope and applications, Types of power converters, Power semiconductors switches and their V I Characteristics – Diodes, SCR, TRIAC, Power BJT, POWER MOSFET, IGBT

2. **AC-DC Converters** – Rectifiers: Introduction, Diode - Passive rectifiers, Principles of phase controlled converters operation, Single and Three phase controlled converters, Analysis with and without free wheeling diode of R, R-L, and RLC load, Single phase and three phase dual converters, Effect of load and source inductances, General idea of gating circuits.
3. **DC-DC Converters:** Introduction, types and circuit configurations (buck, boost, buck/boost, cuk, converters with transformers), principles of operation and properties, advantages and disadvantages.
4. **DC-AC Converters** - Inverters: Introduction, Single phase and three phase inverters with PWM and square wave operation. Uni-polar and Bi-polar mode of operation. Ripples and harmonic distortions in inverters with various operating modes.
5. **AC-AC Converters:** Single-phase and Three-phase ac-ac voltage controllers. Single-phase to Single-phase, Three-phase to single-phase and three-phase to three-phase configurations of Cycloconverters, Basics of Matrix converters
6. **Accessories and Auxiliary Circuits:** Heatsinks, Snubber circuits, Gate drive circuits, Design of Magnetic Components

List of Experiments

1. Experimental study of the characteristics of SCR and TRIAC
2. Introduction to working with analogue and digital oscilloscopes.
3. Experimental study of the operation single-phase phase controlled bridge rectifier with R, RL and RLC load.
4. Experimental study of the operation of simple PWM modulated switch with RL load.
5. Experimental study of buck converter in various operating modes.
6. Experimental study of boost converter in various operating modes.
7. Introduction to Power Electronic circuit simulation in pSpice.
8. pSpice simulation of simple PWM modulated switch with RL load.
9. pSpice simulation of buck converter in various operating modes.
10. pSpice simulation of ac-dc power supply based on single-phase bridge rectifier and buck dc-dc converter.

Reading list

1. N. Mohan, T.M. Undeland, W.P. Robbins, (2009), "Power Electronics: Converters, Applications and Design", Wiley India Pvt Ltd.
2. M.H. Rashid (2003), "Power Electronic Circuits, Devices and Applications", Prentice Hall of India Pvt Ltd.
3. P.S. Bimbhra (2000), "Power Electronics", Khanna Publishers, India.
4. V. Subramanyan (2001), "Power Electronics", New Age International Publisher, India.
5. C. W. Lander, (1993), "Power Electronics", Mc Graw Hill International edition.

Date: 3 June 2011

Name of the Module **:** Power Transmission and Distribution

Module Code **:** PSS302

Semester	**:**	VI
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mr. Roshan Chhetri

General objectives or aims of the module:

The module will enable students to understand, analyze and design electrical power transmission and distribution systems including power system planning and voltage control. The module also introduces advanced power systems.

Learning outcomes:

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

1. Have general concepts of different terms used in power transmission and distribution systems.
2. Identify different types of conductors; both underground and overhead conductors used in transmission and distribution systems and their installations.
3. Calculate line parameters including the effects of earth on line parameters.
4. Determine ABCD parameters of short, medium and long transmission lines and their interpretations.
5. Find regulation and efficiency of lines and string efficiency of overhead insulators.
6. Calculate line losses and understand the various types of series and shunt compensation in lines.
7. Enumerate electrostatic and electromagnetic interferences with other lines in the vicinity, radio interference and calculate corona loss.
8. Calculate sag in OH line considering the weight of the conductor, Tension, Wind load, Ice load (snow prone areas), temperature, safety factor, spacing and falling objects and use table to determine sag and sag templates.
9. Determine insulation resistance, inductance, stress, capacitance and grading of different underground cables.
10. Understand transmission and distribution system planning, and AC and DC load flow models.
11. Explain voltage control of transmission line, travelling waves on transmission line, excitation and governing systems.
12. Identify, formulate and organize engineering problems in a conceptual form as well as in terms of mathematical and physical models.

Learning and teaching approach used

- Lectures : 3 hours per week.
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment:

Continuous assessment - 30 marks

1. Assignments (open books) :10 marks
2. Class tests (closed books) :10 marks
3. Mid-term test (closed books) :10 marks

Semester End Examination - 70marks

1. Semester End Examination (closed books, 3 hours) : 70 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%.

Pre-requisite : Power Generation

Subject matter

1. **OH Transmission Line**: Types of Conductors classification and application; Line Parameters - Calculation of inductance and. Consideration for effect of Earth; Generalized ABCD constants and equivalent circuits of short, medium & long lines. Interpretation of long line equations: surge Impedance loading, tuned power lines, Ferranti effect; Line Performance - Regulation and efficiency of short, medium length and long lines
    - ***Overhead Line Insulators*** - *Types, string efficiency, grading ring, preventive maintenance.*
2. **Corona:** Visual and disruptive critical voltages, Corona loss; Electrostatic and electromagnetic interference with communication lines, Radio interference; Factors affecting Corona: Choice of voltage and conductor size.
3. **Mechanical Design:** Types of supporting structures ; Calculation of sag and tension, sag templates, stringing chart; Elementary ideas of conductor vibration, vibration dampers and armour rods.
4. **Underground Cables**: Types of insulating materials, single core and 3-core cables; Breakdown of cable insulation; High voltage cables - gas and oil pressure cables; Stress and capacitance for single and three core cables; Economic conductor diameter; Capacitive and intersheath grading, Sheath losses; Condenser bushing, Thermal characteristics; Methods of laying cables; Cables for direct current transmission.
5. **AC Distribution System**: Classification, requirement of Distribution system, Primary and secondary distribution system; comparison of UG and OH; Voltage drop and power loss calculations,
6. **Voltage Control**: Tap changing transformer, phase control, booster transformers and phase shifting transformer; Series and shunt compensations; Location and protection of series capacitors, advantages and problems
7. **Grounding of System Neutrals:** Ungrounded system and effective grounded system; Resistance, reactance and resonant grounded systems, and their merits and demerits.
8. **Transmission System and Distribution System Planning:** Criterion for transmission planning; AC and DC load flow models; Economic and reliability consideration, Methods of planning; Criterion for distribution planning; Various distribution strategies for rural and urban systems.

9. **Travelling Waves:** Travelling waves on transmission lines; Wave equations and specification of travelling waves; Reflection and refraction of travelling waves; typical cases of line terminations.
10. **Basic Controls of Synchronous Generators:** Types of excitation systems - DC excitation, AC excitation and Solid-State excitation systems; Speed governing system.

Reading lists:

1. WD Stevension (1982)), "Elements of Power System Analysis", Mc Graw Hill, New York.
2. J. Nagrath, D.P. Kothari (2003), "Power System Engineering", Tata Mc Graw Hill, New Delhi.
3. C. L. Wadhwa (2003), "Electrical power System", New Age International, New Delhi.
4. B R Gupta, (2003), "Power System Analysis and Design", Wheeler Publishing.
5. A S Pabla, "Electrical Power Distribution Systems Planning", Mcmillan India Ltd.
6. C.M. Arora, "Power System Engineering".
7. J. Nagrath, D.P. Kothari (2003), "Modern Power System Analysis", Tata Mc Graw Hill, New Delhi.
8. Soni, Gupta and Bhatnagar, "Electrical Power Systems", Dhanpat Roy and Sons Publishers, New Delhi.

Date: 3 June 2011

Name of the module	**:**	Microprocessor and Interfacing
Module Code	**:**	SAS302
Semester	**:**	VI
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Dr. Kazuhiro Muramatsu

General Objectives:

This module will familiarize students with the concept of Microprocessors and its interfacing, that is essential for Electrical Engineering at BE level. The module will also develop student's abilities, to program and interface Microprocessor with other programmable devices.

Learning Outcomes

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

1. Upon Successful completion of the course the student will be able to
2. Differentiate between compiler, interpreter, and assembler
3. Identify three bus Architecture of microprocessor.
4. Draw State transition diagrams for memory read, memory write and I/O read write cycles
5. Design and draws the memory mapping for RAM and ROM used with MPU
6. Use Microprocessor Instruction Set to write assembly language program for MPU 8085
7. Explain the address decoding techniques used with I/O devices
8. Write Assembly language programs for interfacing 8255A Programmable Peripheral Interface with MPU.
9. Write Assembly language programs for interfacing 8254 Programmable Timer with MPU
10. Interface ADC and DAC with MPU
11. Demonstrates different applications of 8085

Learning and Teaching Approach used:

- Lecture : 3 hours per week
- Practical : 2 Hour per week
- Self study : 7 hours per week

Assessment:

- **Theory – 75 marks**

Continuous Assessment - 25 marks

1. Assignments : 5 Marks
2. Midterm test : 10 Marks
3. Quiz / Surprise test : 5 Marks

4. Case study : 5 Marks

Semester End Examination – 50 marks

1. Closed Book, 3 hours duration – 50 marks

- **Practical Continuous Assessment – 25 marks**

1. Regular Laboratory assessment – 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%.

Pre-requisite : Digital Electronics and Logic Design

Subject matter

1. **Microprocessor Architecture, Ideal Microprocessor, Practical limitation:** The data Bus, the address bus and control bus, general microprocessor; C.P.U. architecture, ALU, Internal registers and their use. Timing and control Instruction word flow Data word flow State transition diagrams.
2. **Semiconductor Memories:** Volatile and non-volatile memories, RWM - static and dynamic types, Examples ROM - Masked ROM, PROM, EAROM, Interfacing of memory chips with microprocessor.
3. **Microprocessor Instruction Set (8085/ 8086**): Addressing modes, status register with C, Z, S, P, and AC flags. The binary code, hexadecimal code for each instruction. Opcode fetch machine cycle. WRITE / READ machine cycle, Interrupt acknowledge machine cycle and their Timing diagrams, Memory mapping, Address decoding technique, Memory mapped I/O and peripheral mapped I/O) Interrupts, RST and Hardware interrupts. Brief idea of assembler, compiler, loader, monitor and other software aids, software development methodology Assembly language fundamentals and programming M.L. Programming, Simple examples with Subroutines.
4. **8255A Programmable Peripheral Interface:** Pin configuration, Logic symbolism functional description, Operating modes, Interfacing and Programming of the device, Introduction to 8237 (DMA handler) and 8259 (Interrupt handler)
5. **8254 Programmable Timer:** Pin configuration, Logic symbolism and Functional description, Interfacing, Operating modes and Programming of the device.
6. **ADC and DAC:** ADC 0800 I.C Chips, their pin configurations, Logic symbolisms, functional description, Sample and hold, Interfacing and Subroutines
7. **Microprocessor Applications:** Microprocessor selection, Design methodology, Simple examples of applications, Numerical relays.
8. **Introduction to architecture of modern microprocessors:** Implementing assembly programming with C language platform.

List of practicals:

1. Basic introduction to assembly instructions. (Free rudimental assembly software for PC is available online.)
2. Introduction to 8085/ 8086 Microprocessor Kit – memory mapping for the assigned kit, utility programs
3. Assembly language problems – to verify and observe the output of assembly program using basic data transfer and data manipulation method
4. To write language program stowing looping, counting and indexing
5. To study the Stack and Subroutines
6. BCD Arithmetic and Code Conversion
7. Interfacing of DAC and ADC to Microprocessor 8086
8. Serial transmission & Interrupt handling

Reading List:

1. Gaonkar R.S.(2002), "Microprocessor Architecture, Programming & Applications with the 8085/8085", Latest edition, Willey, Eastern Ltd New Delhi.
2. Rifiquazzaman M, "Microcomputer theory & application with the INTEL-SDK-85", John Willey & sons, New York.
3. Barry B. Brey (2005), "The Intel Microprocessors, Architecture, Programming, and interfacing", 7th edition, Prentice Hall of India, PHI Private Limited, New Delhi.
4. Srinath N. K, (2005), "8085 Microprocessor: Programming and Interfacing", 2nd edition, Prentice Hall of India, PHI Private Limited, New Delhi.
5. Short K.L, "Microprocessors and Programme Logic", 2nd edition, Prentice Hall of India, PHI Private Limited, New Delhi.
6. Mathur A.P (1999), "Introduction to Microprocessors", Tata McGraw Hill, New Delhi.
7. Liu & Gibson,(2005), "Micro-computer System Architecture, Programming and Design", 2nd edition, Prentice Hall of India, PHI Private Limited, New Delhi.
8. L.Leventhal, "8085A/8085 Programming Language", Mc-Graw Hill, Singapore.
9. Roger L Tokheim (1986), "Micro Processor Fundamentals Schaum's Outline Series", 1st edition, Assian Student Edition, McGraw Hill Book Company, New Delhi.
10. Pal Ajit , (2001), "Microprocessors Principles and applications", Tata McGraw Hill, New Delhi.

Date: 3 June 2011

Semester VII

Name of the Module	**:**	Power System Analysis
Module Code	**:**	PSS401
Semester	**:**	VII
Credit Value	**:**	12
Module Leader	**:**	Dr. Andu Dukpa
Module Tutor	**:**	Dr. Andu Dukpa and Mr. Roshan Chhetri

General objectives or aims of the module:

This module will familiarize students with the different spectrum of power system analysis carried out in a conventional power system. The module will make the students understand the terminal conditions and nature of power system planning that makes each of the analysis procedures significant

Learning outcomes:

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

1. Classify power system busses and identify their practical and theoretical significance.
2. Distinguish between steady state, transient and sub transient operating conditions.
3. Use iterative methods for different power system analysis procedures involving nonlinear equations.
4. Use sequence component transformation and inverse transformation for analysing unbalanced faults at power system terminals.
5. Apply the equal area criteria to the swing equations to determine the power system stability.
6. Distinguish between the steady state and transient stability limits of a power system.
7. Recognize the factors that influence the steady state and transient stability limits of power systems.

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. 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.

- Lectures : 3 hours per week
- Practical/Computer based simulation session : 2 hours per week
- Self study : 7 hours per week

Assessment

- **Theory – 75 marks**

Continuous assessment - 25 marks

1. Mid Term Test (One test, 10 marks)
2. Assignment (Two assignments, 10 marks)

3. Quiz (One Test, 5 marks)

Semester End Examination - 50 marks

1. Written examination (One test of three hours duration, 50 marks)

- **Practical Continuous assessment - 25 marks**

1. Regular Lab assessment (computer based simulation) - 15 marks as shown in annexure – I
2. Viva and Exam - 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%.

Pre-requisite: Power Transmission and Distribution

Subject matter:

1. **System Representation:** Single line representation, Per Unit Systems, modelling of transformer, load, synchronous machine.
2. **Formation of Network Matrices:** Bus admittance and impedance matrices, Algorithms for formation of Z-Bus and Y-Bus matrices, modification of Z-Bus and Y-Bus matrices. Sparsity oriented inversion for Y-Bus.
3. **Symmetrical Components Transformation:** Significance of positive, negative and zero sequence components, Average 3-phase power in terms of symmetrical components, Sequence impedances and sequence networks of power system components.
4. **Short Circuit Studies:** Short circuit studies for balanced three phase networks for various types of shunt faults using sequence networks (with and without considerations for pre-fault load current), Short circuit studies using Z-Bus matrix, Short circuit capacity of a Bus, Various reactor schemes and applications.
5. **Load Flow Studies:** Bus classification; Developing load flow equations; Solution techniques – Iterative methods: Gauss, Gauss-Seidal, Newton Raphson and Fast-decoupled method; Acceleration of convergence; Comparison of different methods, merits and demerits.
6. **Stability Studies:** The stability problem, Swing Equation, Power angle equation, Equal area criterion of stability, Representation of network, load and generators; Elements of steady state and dynamic stability studies; Factors affecting transient stability and the methods of simulation.
7. **Power System Monitoring and Control:** Economic operation and load dispatch, Elementary ideas of Voltage, VAR and load frequency controls, Hydro and steam turbine governors, Tie-line bias control.

List of Practicals:

1. To Study an artificial Transmission Line simulator and determine the line parameters (ABCD constants) through open circuit and short circuit tests on the line.
2. To Study an artificial Suspension String simulator, determine the voltage distribution across a string of disc insulators and verify the string efficiency improvement upon increasing cross arm, capacitance grading and static shielding.
3. To study the Shunt and series compensation of transmission lines.

4. To study the reactive power control by a tap changing transformer.
5. To determine the fault location in a cable using cable fault locater.
6. To study the L-G, L-L-G, L-L, L-L-L faults on a transmission line fault simulator.
7. To study an earth fault in a transmission line with and without using a Petersen coil.
8. To study the power flow analysis through various iterative techniques.
9. To determine the direct axis reactance (X_d") and quadrature axis reactance (X_q") of an alternator.
10. To determine the negative and zero sequence reactances of an alternator.

Reading list

1. A.R. Gergen (2001), "Power system Analysis", Prentice hall Inc.
2. L.P. Singh (2001), "Advanced Power System Analysis and Dynamics", 3rd edition, New Age International Publishers, New Delhi.
3. I.J. Nagrath and D.P. Kothari (2000), "Modern Power System Analysis", 2nd edition, Tata McGraw Hill, New Delhi.
4. W.D. Stevenson (2000), "Elements of Power System analysis", 4th edition, Tata McGraw Hill Ltd, New Delhi.
5. J. John Gainger and W.D. Stevenson Jr., "Power System analysis", McGraw Hill, New York.
6. P. Kundur , "Power System Stability and Control", McGraw Hill Inc, New York.
7. C. L. Wadhwa (2003), "Electrical power System", 3rd edition, New Age International Ltd., New Delhi.
8. B R Gupta (2001), "Power System Analysis and Design", 3rd edition, Wheeler Publishing, New Delhi.
9. Husain Ashtaq (2004), "Electrical Power Systems", 4th edition, CBS Publishers and Distributors, New Delhi.

Date: 3 June 2011

Name of the Module	**:**	Switch Gear and Protection
Module Code	**:**	PSS402
Semester	**:**	VII
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mr. Cheku Dorji

General objectives or aims of the module:

This module will introduce the concept of switchgears and their use for protection in power systems. The module will develop the students' abilities to solve numericals regarding the system safety

Learning outcomes:

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

1. Upon successful completion of this course the student will be able to:
2. Classify various relays based on the construction and working principle.
3. Plan different schemes for the protection of various equipments used in the substations in case of any disturbance like lightning or switching surges.
4. Analyse different protective schemes for the transmission lines.
5. Solve different numerical problem regarding PSM. TSM, pickup, grounding resistors& safety of various equipments.
6. Analyse the construction and working principle of modern static and microprocessor based relays
7. Analyse various methods and schemes of generator, transformer,& bus zone protection
8. Describe various circuit breakers used in the power system, their construction, working principle, advantages and disadvantages.
9. Recognise different arrangements of bus bars in the substation.
10. Recognise different methods of grounding
11. Distinguish & describe Indoor and outdoor substations

Learning and teaching approach used:

- Lectures : 3 hours per week
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment

- **Continuous assessment: 30 marks**

1. Assignment : 10 marks
2. Class Tests (closed book) : 5 marks
3. Mid –Term test : 10 marks
4. Case study : 5 marks

Semester End Examination: 70 marks

1. Written examination : 3 hr,70 marks, 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. **Protective Relays:** Introduction. Need for protective systems, effects of faults, Zones of protection, Primary and backup protection, Essential qualities of protection, Classification of protective relays and schemes.
2. **Operating Principles and Relay Construction:** Electromagnetic relays, thermal relays, static relays, microprocessor based protective relays
3. **Over Current Protection:** Time-current characteristics, Current setting, Overcurrent protective schemes, Protection of parallel feeders, Protection of ring mains, Earth fault and phase fault protection, Combined earth fault and phase fault protective scheme, Directional earth fault relay.
4. **Distance Relays :** Impedance relay, reactance relay, MHO relay, Effect of arc resistance on the performance of Distance relays, Effect of power surges (Power swings) on the performance of distance relays, Effect of line length and source impedance on relays, Selection of distance relays, MHO relays with blinders.
5. **Pilot Relaying Schemes:** Wire pilot protection, Carrier current protection**.**
6. **AC Machines and Bus Zone Protection:** Protection of generators, Transformer protection, Bus-zone protection, Frame leakage protection.
7. **Static Relays:** Amplitude and phase comparators, Analysis of duality, static amplitude comparators, and Static phase comparators
8. **Circuit Breakers**: Arc voltage, arc interruption, Restriking voltage and Recovery voltage, Resistance switching, Current chopping, Classification of circuit breakers -, SF6 CB, Vacuum CB, Operating mechanism, Selection of circuit breakers, High voltage DC circuit breakers, Testing of circuit breakers.
9. **Numerical Relays:** Introduction, construction, principle of operation, advantages and applications.
10. **Substation Equipment:** Busbar arrangements and sub-station layout ,Distribution sub-station bus-bar connections Isolators, shielding, earthing and earth electrodes, Location of C.Ts and PTs , Earthing mat.

Reading List:

1. BadriRam and D N Vishwakarma (1995), “Power System Protection and Switchgear”, TMH PublishingCompany Ltd. New Delhi.
2. C.L.Wadhwa (2003), “Electrical Power Systems”, Wiley Eastern Ltd. New Age International, New Delhi.
3. A.R. Van C. Warrington, “Protective Relays Theory and Practice Vol.I and II”, Chapman and Hall.
4. Rao S S (2003), “Switchgear Protection and Power Systems”, Khanna Publishers, New Delhi.
5. Ravindranath and Chander (1995), “Power System Protection and Switchgear”, New Age International, New Delhi.
6. C.R. Mason, “Art and Science of Protective Relaying”, John Willey.
7. E.W. Kimbark, “Power System Stability Vol. II”, John Wiulley and Sons, Inc.

8. T.S. Madhava Rao, "Power System Protection; Static Relays", Tata McGraw Hill Publishing Co. Ltd, New Delhi.

Date: 3 June 2011

Name of the module	**:**	Control Systems
Module Code	**:**	CTS401
Semester	**:**	VII
Credit Value	**:**	12
Module Leader	**:**	Mr. Nima Dukpa
Module Tutor	**:**	Mr. Nima Dukpa and Mr Sonam Norbu

General Objectives of the module:

The goal of this module is to allow students understand and apply the fundamental principles for analysis and design of control systems. The module provides students with ample practical problems and their solutions. The laboratory sessions provides opportunity to experiment with actual control systems hardware.

Learning Outcomes:

After completing the module, students are expected to be able to:

1. Analyze the effect of feedback on a system.
2. Model physical (dynamic) systems.
3. Specify and analyze time response specifications (performance Index) of a control system.
4. Compute and/or specify steady-state error specifications of a control system.
5. Design compensators/controllers through root locus design and frequency response techniques;

Learning and Teaching Approach used:

- Lecture : 3 hours per week
- Laboratory Practical : 2 hours per week
- Self study : 6 hours per week

Assessment

- **Theory – 75 marks**

Continuous Assessment - 25 marks

1. Assignments : 10 Marks
2. Midterm test : 10 Marks
3. Quiz / Surprise test : 5 Marks

Semester End Examination – 50 marks

1. Closed Book , 3 hours duration – 50 marks

- **Practical Continuous Assessment - 25 Marks**

1. Regular laboratory assessment - 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%.

Pre-requisite : Mathematics-IV

Subject matter:

1. **Introduction to Control Systems:** System identification; Basic components of a control system; Open-loop control systems; Feedback control systems; Effects of feedback.
2. **Mathematical Modeling of Dynamic Systems:** Laplace transform; System transfer functions (SISO); Dynamic models; State space model; Block diagrams (reduction of multiple subsystem); Physical system modeling (electrical, mechanical or electromechanical systems).
3. **Time Response of Dynamic Systems:** Poles and zeros; Test Signals or Excitation Functions; Order of the System, Type of Systems; First order systems; Second order systems; Under-damped second order systems; Time Response Specifications (Performance Index); Effect of zeros on time response; Response of higher order systems; Stability (Routh-Hurwitz criterion).
4. **Steady-State Errors:** Analysis of steady-state errors; Error constants and system types; Steady-state error specifications.
5. **The Root Locus Design Method:** Root locus of a basic feedback system; Rules for sketching the root locus; Compensator/controller design.
6. **Frequency Response:** Frequency response of a closed-loop system; Frequency-Domain Specifications; Effects of adding zeros and poles in the forward path transfer function; Nyquist stability; Relative stability (gain margin and phase margin); Nichols chart; Design by frequency response methods.
7. **PID controls:** Tuning rules for PID controllers; Modifications of PID control schemes.
8. State Models: Converting a transfer function to state space; Converting from state space to a transfer function; Eigen Values and Eigen Vectors; Similarity transformation; Decomposition of transfer functions; Controllability and Observability of linear systems.
9. **Digital Control System:** The z-transform, Properties of Z-Transform, The Z Transfer Function (Pulse Transfer Function), The Inverse Z-Transform, Z and S Domain Relationship.

List of experiments

1. Dynamic response of 1st and 2nd order systems
2. P Controller for 1st order system
3. PI, PD, and PID Control for 1st order system
4. PID Controller for 2nd order system
5. PID parameter tuning with Zieglar Nichols 1st and 2nd methods
6. Designing linear systems and P-Controller with OP-Amps

7. Designing interlocks or sequential control with digital ICs.

Reading List

1. Ogata Katsuhiko (2004), "Modern Control Engineering", 4th edition, Prentice Hall of India, PHI Private Limited, New Delhi.
2. Dorf Richard C and Bishop Robert H (2002), "Modern Control Systems", 8th edition, Pearson Education, Singapore.
3. Norman S. Nise. "Control Systems Engineering", 4th edition, Wiley.
4. Benjamin C. Kuo and Farid Golnaraghi. "Automatic Control Systems", 8th edition, Wiley.
5. W. Bolton (2003), "Mechatronics", 5th reprint, Pearson Education, (Singapore) Pte. Ltd., Indian Branch, Delhi.
6. IEC (International Electrotechnical Commission) Standard 61511, Functional Safety: Safety Instrumented System for Process Industry Sector,
7. Stanley Wolf and Richard F.AM. Smith (2005), "Student Reference Manual for Electronic Instrumentation Laboratories", Prentice-Hall of India, Private Limited, New Delhi.
8. Mike W. Martin and Roland Schinzinger (2003), "Ethics in Engineering", 4th edition, Tata McGraw-Hill, New York.
9. Nagrath I J and Gopal M (1999), "Control System Engineering", Willey Eastern, New Delhi.
10. Gibson and Tuteur (2003), "Control System Components", McGraw Hill. Singapore.

Date: 3 June 2011

Name of Module	**:**	Digital Signal Processing
Module Code	**:**	SAS401
Semester	**:**	VII
Credit value	**:**	12
Module Leader	**:**	Mrs. Karma Kezang Eudon
Module Tutor	**:**	Mrs. Karma Kezang Eudon

General objectives:

This module will develop comprehensive grounding in Digital Signal Processing (DSP) concepts and algorithms plus practical information on the design and implementation of DSP systems. Also this module will familiarize the students with DSP principles and their implementation and equips the students to put the ideas into practice and tackle more advanced aspects of DSP.

Learning outcomes:

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

1. Describe the structure of a classical DSP system and the application of DSP
2. Define Discrete Time Signals and develop algorithms for analyzing discrete time signals.
3. Demonstrate an understanding of the z-transform, Discrete fourier Transform (DFT), Fast Fourier Transform algorithm, and their uses.
4. Analyze LTI systems and Inverse systems.
5. Design FIR digital filters, IIR Digital filters: Butterworth and Chebyshev filters, Low pass, Band Pass, Band stop and High Pass filters
6. Perform Parametric and non parametric spectral estimation
7. Apply DSP technique to Speech, image and Radar Signal processing.

Learning and teaching approach used:

- Lecture : 3 hours per week
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment:

- **Continuous Assessment - 30 marks**

1. Assignment - 10 marks
2. Case Study – 10 marks
3. Closed book mid-term test – 10 marks

Semester End Examination – 70 marks

1. 3 hrs written examination (closed book) - 70 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%.

Pre-requisite : Signals and Systems

Subject matter:

1. **Discrete time signals** - sequences, representation of signals, on orthogonal basis: Sampling and reconstruction of signals
2. **Discrete Signals:** Attributes, Z-Transform, Analysis of LTI systems, Frequency analysis, Inverse systems, discrete fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete Time Systems.
3. **Design of FIT digital filters:** window methed, Park McClellan's Method, Effect of finite register length in FIR filter design.
4. **Design of IIR Digital filters:** Butterworth, Chebyshev and Elliptic Approximation; Low pass, Band Pass, Band stop and High Pass filters.
5. **Parametric and non parametric spectral estimation.** Introduction to multirate signal processing.
6. **Application of DSP to Speech and Radar Signal processing.**

Reading list:

1. AV Oppenheim and Schafe (2000), "Discrete Time Signal Processing", Prentice Hall, New Delhi.
2. John G Prokis and D G Manolakis (1997), "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall.
3. Steven Smith, (2003), "Digital Signal Processing", A Practical Guide for Engineers and Scientists, Elsevier.

Date: 3 June 2011

Name of the Module	**:**	Project
Module Code	**:**	PRW 401
Semester	**:**	VII
Credit Value	**:**	0
Tutors Leader	**:**	Mr. Roshan Chhetri
Tutors Tutor	**:**	Mrs. Karma Kezang Eudon

General objectives or aims of the module:

To familiarize students with the literature survey and the process of defining a problem for project work.

Learning outcomes:

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

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

Learning and teaching approach used

Directed reading and assigned problems develop inquisitiveness for bridging the current research loopholes and assist in research problem formulation. Application oriented projects require knowledge of various industrial standards and utility aspects, which can be gathered through directed studies.

- Self Study : 4 hours per week

Assessment:

- A Unified assessment for the project will be done at the end of eighth semester

Subject matter

1. This will depend upon student's interest and the Guide's expertise. Literature review, proposal, work plan, finalization of topic.

Reading list:

1. Current research topics from research magazines.

Date: 3 June 2011

Name of Module	:	Seminar
Module Code	:	SEM401
Semester	:	VII
Credit value	:	6
Module Leader	:	Mr. Roshan Chhetri
Module Tutor	:	Mr. Sonam Norbu

General objectives:

Seminars are designed to acquaint the student with aspects of Electrical Engineering that are not normally encountered in classes and institute activities and include a wide range of topics.

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 15 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	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,	10
	vi. Effective communication of the points of one's argument	10
	v. Use of Presentation Aids (PC/Projector. OHP, White Board, Handouts,	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: 3 June 2011

Elective –I

Name of the Module	**:**	Computer Aided Design of Electrical Equipment
Module Code	**:**	EMC401
Semester	**:**	VII
Credit Value	**:**	**12**
Tutors Leader	**:**	Mr. Roshan Chhetri
Tutors Tutor	**:**	Mr. Cheku Dorji

General objectives or aims of the module:

This module will familiarize students with the basic optimization techniques and to utilize them for the optimal design of various electrical machines. And enhance the designing efficiency by characterizing optimization with the aid of computers.

Learning outcomes:

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

1. Utilize appropriate optimization tools in the design process.
2. Apply flow-charts, algorithms and computer programs for the optimum design of various electrical machines.
3. Practice computer aided design of electrical equipments.

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. 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.

- Lectures : 3 hours per week
- Computer based simulation session : 1 hour per week
- Self study : 6 hours per week

Assessment

Continuous assessment - 30 marks

1. Mid Term Test : 10 marks
2. Assignment : 15 marks
3. Computer based design simulation : 5 marks

Semester End Examination - 70 marks

1. Written examination (One test of three hours duration, 70 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. **Design Principles:** Review of design process of transformers - power, distribution, small transformers and inductors; Review of design process of induction, Synchronous and D.C. machines.
2. **Computer Aided Design:** Philosophy and economics of C.A.D., its advantages and limitations; Selection of input data and design variables; Flow chart for design of transformer and rotating machine; Analysis and synthesis approach and their scope of applications to a.c. and d.c. machines.
3. **Design Optimization:** Statement & classification of optimization problems; Nonlinear unconstrained optimization Techniques - Random search, univariate, Hook & Jeeve's simplex, Powell's & D.F.P. methods; Nonlinear constrained optimization Techniques: direct search methods- Box's complex, Rosenbrock's methods; Indirect search methods- Interior penalty function approach; Optimization problems formulation of transformer, induction, synchronous and d.c. machines; Development of flow-charts and computer algorithm for the optimum design of various electrical machines.

Reading list

1. Ramamoorty M. (1987), "Computer Aided Design of Electrical equipments", 1st edition, Affiliated East West Press Pvt. Ltd. New Delhi.
2. Sen S.K., "Principles of Electrical Machine Design with Computer Programmes", Oxford and IBH Publishing Co Private Ltd.
3. Rao S.S., "Optimization Techniques –Theory and applications",
4. Kalyanmoy Deb, "Optimization for Engineering Design –Algorithms and examples", PHI, Eastern Economy Edition.

Date: 3 June 2011.

Name of the Module	**:**	Artificial Intelligence Techniques
Module Code	**:**	AIT401
Semester	**:**	VII
Credit Value	**:**	**12**
Module Leader	**:**	**TBA**
Module Tutor	**:**	TBA

General objectives or aims of the module:

The module will introduce students to artificial intelligence, statistical reasoning, artificial neural networks and expert systems.

Learning outcomes:

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

1. Have general concepts of artificial intelligence (AI), application, components of an AI program, production system and problem characteristics.
2. Explain overview of searching techniques, knowledge representation, knowledge representation issues and an overview.
3. Represent knowledge using rules, procedural versus declaration knowledge.
4. Write logic programming.
5. Explain forward versus backward reasoning, MATCHING and control knowledge.
6. Introduces probability and Baye's theorem used in AI.
7. Describe certainty factor and rule based systems used in AI
8. Understand biological neuron and neural net, and their applications use in AI.
9. Analyze perception, idea of single layer and multi-layer neural nets, back propagation, Hopfield nets, supervised and unsupervised learning, and their applications in AI programming.
10. Explain expert systems, expert system building tools and shells components of expert systems.

Learning and teaching approach used

- Lectures : 3 hours per week
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment

Continuous assessment - 30 marks

1. Assignments (open books) : 10 marks
2. Class tests (closed books) : 10 marks
3. Mid-term test (closed books) : 10 marks

Semester End Examination - 70marks

1. Semester End Examination (closed books, 3 hours): 70 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. **Introduction to AI:** Definition of artificial intelligence (AI) and application; Components of an AI program, production system and problem characteristics; Overview of searching techniques, Knowledge representation, knowledge representation issues and an overview; Representing knowledge using rules, procedural versus declaration knowledge; Logic programming; Forward versus backward reasoning, MATCHING and control knowledge.
2. **Statistical Reasoning:** Introduction to probability and Baye's theorem; Certainty factor and rule based systems.
3. **Artificial Neural Networks:** Biological neuron, neural net, use of neural nets in AI and applications; Perception, idea of single layer and multi-layer neural nets; Back propagation, Hopfield nets, supervised and unsupervised learning.
4. **Expert Systems:** Basic idea of expert systems; Expert system building tools; Shells components of expert systems.

Reference books

1. Elaine Rich and Kevin Knight (1991), "Artificial Intelligence", TMH Publications, New Delhi.
2. Anderson James A. (2006), "An Introduction to Neural Networks", Prentice Hall, New Delhi.
3. Dan. W. Patterson (1992), "Artificial Intelligence and Expert systems", Prentice Hall of India, New Delhi.

Date: 3 June 2011.

Name of the Module	**:**	Opto Electronics
Module Code	**:**	ELE401
Semester	**:**	VII
Credit Value	**:**	**12**
Module Leader	**:**	Mrs. Karma Kelzang Eudon
Module Tutor	**:**	Mrs. Karma Kelzang Eudon

General objectives or aims of the module:

This module will develop the concept of Wave-guide and optical fibre and their applications, which are essential for an electrical engineering graduate at BEng level. Also introduce the theory of optical computing to the students.

Learning outcomes:

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

1. Discuss and analyse the wave-guides and fibre materials and manufacturing.
2. Discuss and differentiate photo sources and detectors.
3. Apply Fourier optics and understand Holography.
4. Analyse optical communication system and understand optical fibre sensors.
5. Discuss optical computing and its application.

Learning and teaching approach used

- Lecture : 3 hours per week
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment

Continuous assessment - 30 marks

1. Assignment : 10 marks
2. Class tests: closed book : 10 marks
3. Closed book midterm test : 10 marks

Semester End Examination - 70marks

1. Written examination: 3 hrs closed book, : 70 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. **Wave guides & optical filters:** Dielectric slab waveguides, step & graded Index optical filters, structures, Fibre parameters, modes of propagation, signal degradation, fibre jointing, fibre materials and manufacturing.
2. **Photo Source and Detectors:** Injection luminescence and the light emitting diode (LED), materials, constructions, drive circuitry, fundamentals of lasers, Einstein

relations, Semiconductor lasers – Heterojunctions, the optical resonator laser, Characteristics of laser radiations, single mode operations, Compound cavity and distributed feedback lasers, photo detectors – PIN and APD, responsivity, response time, detector performance parameters.

3. **Electro Optic Effect:** EO Retardation, Amplitude, Phase and frequency modulation, beam deflection, Acousto-optics, AO device, Non linear optics-second harmonics generation, parametric amplification, oscillation, materials perspective.
4. **Fourier Optics and Halography:** Fourier transforming property of lens, Image forming property of lens, Halography-inline, Off Axis, Holographic interferometry, Holographic storage.
5. **Optical Communication systems:** Analog and Digital Modulation schemes, FO Communication system (Block diagram), FO Local Area Networks,
6. **Optical Fibre Sensors:** Passive, Active Multimode FO sensors, Single mode FO sensors, Phase modulated, Polarization modulated, Fibre Optics Gyroscope.
7. **Optical Computing:** Optical analog computing, digital optical computing, optical interconnects, optical computing by symbolic substitution, the residue number system.

Reading list:

1. J Wilson and JFB Hawkes, "Opto Electronics, An Introduction", PHI Pvt. Ltd. New Delhi.
2. I P Kaminov, "An Introduction to Electro Optic Devices", Academic Press, New York
3. A Yariv, "Optical Electronics", CBS Collage Publishing, New York.
4. A K Ghatak & K Thyagrajan, "Optical Electronics", Cambridge University Press.
5. F Zernike and J E Midwinter, "Applied Non Linear Optics", John Willey & Sons, New York.
6. FTS Yu, "Optical Information Procesing", Wiley, New York.
7. A Selvarajan and Krishna Swami, "Opto Electronics", Current Trends, TMH, New Delhi.

Date: 3 June 2011

Name of Module	:	Industrial Electronics and Drives
Module Code	:	EME402
Semester	:	VII
Credit value	:	12
Module Leader	:	Dr. Andu Dukpa
Module Tutor	:	Dr. Andu Dukpa and Mr. Sonam Norbu

General objectives:

This module will familiarize the students with concepts of industrial electronic devices and their applications. It will also introduce the basic characteristics of motors for understanding the use of particular motors in various applications

Learning outcomes:

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

1. Define the basic components of an electric drive system.
2. Identify and understand the basic types of solid-state converter circuits.
3. Demonstrate knowledge and understanding of the performance, characteristics and operation of a range of industrial drive systems
4. Demonstrate knowledge and understanding of the advantages and disadvantages of different types of power converter and drive systems
5. Select a suitable power electronic device for a given power converter specification
6. Specify an electric drive for a given requirement.
7. Design protection circuits for power electronics devices.
8. Simulate electric drive system using appropriate software

Learning and teaching approach used:

- Lecture : 3 hours per week
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment

Continuous Assessment - 30 marks

1. Assignment - 10 marks
2. Class tests – 20 marks (two tests 10 marks each)

Semester End Examination – 70 marks

1. 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 : Power Electronics

Subject matter:

1. **Power Electronics Components and Basic Control Circuits:** Review of characteristics and limitations: diode, thyristor, gate-turn-off-thyristor, bipolar transistor, MOSFET, IGBT, packages, selection of devices, gate/base circuits.
2. **Heating and Cooling Losses:** Thermal resistance, transient thermal resistance, cooling, model of switching losses.
3. **Protection Circuits in Three Phase Rectifiers:** Review of main features of a three phase diode bridge rectifier; identification of components storing energy under fault conditions; design calculations to minimise the size of a selected protective capacitor system.
4. **Induction Motor Drives:** Control methods, voltage drive and current drive, quasi-square wave, PWM, sine-wave, Kramer, cyclo-converter and harmonics.
5. **Synchronous Motor Drives**: dc link, starting, power converter.
6. **Brushed Dc Drive Systems:** Equations of motion and characteristics of operation. Methods of controlling using constant voltage and constant current techniques. Integration into a complete servo system.
7. **Brushless Dc Drive Systems:** Types of motor construction of the two commonly used motor drives in industry. Characteristics of the operation of motor and amplifier combinations, using two types of sensor feedback.
8. **Stepping drives systems:** Types of motor construction; Variable reluctance; Permanent magnet and Hybrid. Characteristics of motors. Special emphasis on torque curves and methods of controlling using open loop switching amplifiers.
9. **Switched Reluctance Drives:** History, linear analysis, power electronics, practical motors, low and high speed operation.
10. **Simulation Techniques:** Simulate different circuits using Power Electronic Simulation Software.

Reading list:

1. N. Mohan, T.M. Undeland and W.P. Robbins, (2009), "Power Electronics: Converters, Applications and Design", Wiley India Pvt Ltd
2. PS Bimbhra (2000), "Power Electronics", S Chand and Company, New Delhi.
3. B.K. Bose, (2005), "Modern Power Electronics and AC Drives", Prentice-Hall of India Pvt. Ltd, New Delhi.
4. R. Krishnan (2006), "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd.
5. G K Dubey (2000), "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi.

Date: 3 June 2011.

Name of the module	**:**	Advanced Control System
Module Code	**:**	CTS402
Semester	**:**	VII
Credit Value	**:**	**12**
Module Leader	**:**	Mr. Nima Dukpa
Module Tutor	**:**	Mr. Nima Dukpa and Mr Sonam Norbu

General Objectives of the module:

This module will develop basic analytical understanding of advanced Modern Control theory and its applications in the field of Electrical Engineering.

Learning Outcomes:

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

1. Analyze the effect of feedback on a system
2. Design compensator for a system
3. Draws Bode plots and understand its applications
4. Analyse the Control System using State variable models

Learning and Teaching Approach used:

- Lecture : 3 hours per week
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment:

Continuous Assessment - 25 marks

1. Assignments: 5 Marks
2. Midterm test: 10 Marks
3. Case study: 10 Marks

Semester End Examination – 70 marks

1. Closed Book, 3 hours duration – 70 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%.

Pre-requisite : Control System

Subject Matter:

1. **Sampled Data Control System:** Introduction – definition and advantages, typical sampled data control system block diagram; sampler and sampling process; difference equation; Z-transform; Inverse Z transform, Laplace transform of sampled function, Hold circuit, reconstruction of signal (minimum sampling frequency), Pulse transfer

function (or Z-transfer function), Z-transform analysis of sampled data control system, The Z and S domain relationship.

2. **State variable analysis of Linear Dynamic Equations:** Introduction, concepts of state, state variables and state model, state equation for higher order differential equation, solution of state equation, state transition matrix, diagonalization, transfer matrix, concepts of controllability and observability.
3. **Control Actions:** Proportional control, Derivative control, integral control, PD, PI and PID controller, Derivative feedback control
4. **Compensation of Control Systems**: Effects of addition of a zero and a pole to the open loop and closed loop system, need for compensator, classification of compensator based on the location of compensation; Lag, Lead and Lag-Lead compensator (circuit diagram, transfer function, pole-zero configuration, bode plot, relative merits and demerits); Design of compensation using bode plot and Root locus.

List of experiments

1. Study the performance of PD, PI and PID controller using MATLAB.
2. Study the performance of PD, PI and PID controller using trainer kits.
3. Design of Lag, Lead, Lag-Lead compensator.
4. Study the state variable analysis for any typical physical system using MATLAB.
5. Study the Z-transform analysis of any typical sampled data control system using MATLAB.

Reading List

1. Kuo Benjamin C. (2002), "Automatic Control System", 7th edition, Prentice Hall of India, PHI Private Limited, New Delhi.
2. Nagrath I.J. and Gopal M. (1999), "Control System Engineering", New Age International Willey Eastern, New Delhi.
3. Ogata Katsuhiko (2004), "Modern Control Engineering", 4th edition, Prentice Hall of India, PHI Private Limited, New Delhi.
4. Gibson and Tuteur (2003), "Control System Components", McGraw Hill. Singapore.
5. Dorf Richard C. and Bishop Robert H. (2002), "Modern Control Systems", 8th edition, Pearson Education, Singapore.
6. Ogata Katsuhiko (2004), "Discrete Time Control Systems", 2nd edition, Prentice Hall of India, PHI Private Limited, New Delhi.
7. Etter (2004), "Introduction to MatLAB", 2nd edition, Pearson Education, New Delhi.on.

Date: 3 June 2011.

Name of the Module	**:**	Web Technology
Module Code	**:**	CTE404
Semester	**:**	VII
Credit Value	**:**	**12**
Module Leader	**:**	Mr. Tandin Wangchuk
Module Tutor	**:**	Mr. Tandin Wangchuk and Mr Yowaraj Chhetri

General objectives or aims of the module:

The module will enable students to design Web pages using HTML and Java Applet, and introduce to Web Technology.

Learning outcomes:

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

1. Explain internet, web browsers with specific reference to Netscape, Internet explorer, http, ftp and file type URLs, image audio or video formats lige jpeg, gif, png, avi, mpeg and mp3, markup concept and its use in markup languages.
2. Understand HTML Elements.
3. Understand CSSI standard, including style sheets, applying styles to specific groups of elements, creating overall look for web page, basic table elements, combining the tables, CSSI style sheet, Forms, buttons, text field selection list, radio button and check boxes on a web page, submitting and resetting forms with submit and reset button, creating and working with frames, accessing external reference from frames and inline frames with Iframes.
4. Understand and write event driven programs in Java Applet and design web pages

Learning and teaching approach used

- Lectures : 3 hours per week.
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment

Continuous assessment - 30 marks

1. Assignments (open books) : 10 marks
2. Class tests (closed books) : 10 marks
3. Mid-term test (closed books) : 10 marks

Semester End Examination - 70marks

1. Semester End Examination (closed books, 3 hours) : 70 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. **Introduction:** Introduction to Internet, web browsers with specific reference to Netscape and Internet explorer, http, ftp and file type URLs; Image audio or video formats lige jpeg, gif, png, avi, mpeg and mp3; Markup concept and its use in markup languages.
2. **Basic HTML Elements:** Basic structure of an HTML document, doctype, Meta data, link, displaying images, various fonts, colours, sizes and alignments of texts; Lists and tags.
3. **Style Sheet and Tables:** CSSI standard, including style sheets, applying styles to specific groups of elements, creating overall look for web page; Basic table elements, combining the tables and CSSI style sheet.
4. **Creating Forms, Frames and Frame-sheets:** Forms, buttons, text field selection list, radio button and check boxes on a web page; Submitting and resetting forms with submit and reset button; Creating and working with frames, accessing external reference from frames; Inline frames with Iframes.
5. **Event Driven Programming in Java Applet:** Applet architecture and its start, stop, init, paint, and update and repaint methods; Drawing string, lines, polygons, ellipses and circles using abstract windows tool kit package and its classes; Working with colours and fonts; Running applets from HTML with/without PARAM tag; Using button, check box, check box group, choice, list point, text field, text area classes, border layout, card layout and grid layout; Layout managers.

Reading List:

1. Shelly Powers, "Dynamic Web Publishing"' 2nd Edition, Techmedia Pub.
2. Herbert Schildt (2000), "Java 2 - The Complete Reference", 4th Edition Tata Mc-Graw Hill Pub., New Delhi.

Date: 3 June 2011

Name of the Module	**:**	Operations Research
Module Code	**:**	MAT401
Semester	**:**	VII
Credit Value	**:**	**12**
Module Leader	**:**	Mr. S.T. Venkatesan
Module Tutor	**:**	Mr. S.T. Venkatesan

General objectives or aims of the module:
This module will enable the students to take intelligent decisions. Using OR major focus should be on how to model various situations in industries and solve them.

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

1. define Operational Research
2. formulate components of LP problems.
3. describe logic underlining the steps in the simplex method.
4. Solve LP problem by simplex method.
5. Use dual simplex method to find the optimal solution of an LP.
6. Use CPM and PERT to find critical path and time schedule of a project.
7. Define the stead state measures of performance of queuing system.

Learning and teaching approach used:

Lecture	:	3 hours per week
Tutorial	:	1 hour per week
Self study	:	6 hours per week

Assessment:
Continuous Assessment-30 marks
Semester End Examination-70 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. Introduction to operations research techniques and modeling approach and various real life situations.
2. Linear programming problems & Applications, Various components of LP problem formulation, graphical LP solution.
3. Solving Linear Programming problem using simultaneous equations, Graphical Method Simplex method ,Sensitivity analysis, Duality theory revised, Simplex dual simplex
4. Transportation and Assignment Problems.
5. Network Analysis including PERT-CPM Concepts of network the shortest path minimum spanning tree problem maximum flow problem minimum cost flow problems The network simplex method Project planning & control with PERT & CPM
6. Integer programming concepts, formulation solution and applications

7. Game Theory
8. Queuing Theory & Applications
9. Linear Goal Programming methods and applications

Reading list:

1. Operation Research by D.S Hira.
2. Operation Research by D.S Sharma.
3. F.S Hillier & G.J. Lieberman, Introduction to OR, Mcgraw hill Int. Series 1995
4. A Ravindran, Introduction to OR. John Wiley & Sons, 1993
5. R.Kapoor, Computer Assisted Decision Models, Tata Mcgraw Hill 1991
6. Wayne Winston, Operation Research: Applications and Algorithms, Duxbury Press.

Date: 3 June 2011

Name of the Module	**:**	Electrical Installation Design
Module Code	**:**	EID401
Semester	**:**	VII
Credit Value	**:**	9
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mrs. Pema Youden

General objectives or aims of the module:

To develop the basic concept of Design of Electrical Installation for residential and commercial buildings and to introduce use of AutoCAD and other related software.

Learning outcomes:

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

1 Design illumination for indoor and outdoor installation

2 Prepare basic design of lighting scheme for residential, commercial and industrial buildings and draw wiring diagrams and prepare bill of quantities

3 Use Auto CAD and other related software.

Learning and teaching approach used

- Lectures :1 hour per week
- Laboratory practical : 2 hours per week
- Self study : 3 hours per week

Assessment

- **Theory Continuous assessment – 50 marks**

1. Midterm exam -- 10 marks
2. Case Study – 40 marks

- **Practical Continuous assessment – 50 marks**

1. Assignment – 20 marks
2. Project - 30 marks

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

Subject matter:

1. **Illumination:** Various terms and definitions in illumination, Inverse Square Law and Lambert's Cosine law of Illumination. Direct, semi direct, semi indirect, indirect and general lighting schemes. Different types of lamps - incandescent lamp, fluorescent lamp, high pressure vapour lamps, compact fluorescent lamp - on the basis of power consumption, luminous output, life, initial cost, running cost, maintenance, etc.

Illumination design for indoor and outdoor using standard data on illumination and luminaries; street and flood lighting.

2. **Wiring for commercial buildings:** Commercial, industrial and domestic wiring schemes; wiring diagram for the given lay out plan and prepare bill of quantities.
3. **Auto CAD:** Computer aided drawing concept, list of various CAD software available, Auto cad coordinate systems: Cartesian and Polar; drawing using Auto Cad; editing and viewing drawing; layers, block, dimensioning, hatching, model space and paper space view ports layouts.
4. **Electronics Simulation Software:** Drawing of electronic circuits only.

Reading List:

1. Wadha, C L (2000), "Generation, Distribution and Utilization of Electrical Energy", Wiley Eastern Limited, New Delhi.
2. Bhatia, S L 2005, "Handbook of Electrical Engineering", Khanna Publishers, New Delhi.
3. AutoCAD 2005 Manual

Date: 3 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
- Self Study **:** 6 hours 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:

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 behaviour and professional conduct 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.

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, Project management knowledge areas.

8. Project scope management: Define statement/scope of work; Work breakdown structure; Scope Verification and Control; Process for managing changes, Manage expectations.

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: CPM, PERT, PDM); 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 Quality: Define quality; Quality management process; Resolving quality issues; Quality assurance and control.

14. 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.

Date: June 2011

Name of the Module	**:**	High Voltage Engineering
Module Code	**:**	PSS403
Semester	**:**	VIII
Credit Value	**:**	9
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Dr. Andu Dukpa and Mr Roshan Chhetri

General objectives or aims of the module:

This module will familiarize students with the topics in high voltage which are essential. The module will develop the student's abilities to solve numericals in high voltage using the knowledge, understanding and they have gained in the class.

Learning outcomes:

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

1. Identify the different applications of high voltage
2. Analyze basic problems in dealing with high voltage
3. Explain theories of breakdown in gaseous ,liquid ,solid and vacuum medias
4. Distinguish and explain different types of insulations
5. Explain the insulation design of different types of machines
6. Identify and explain the different types of tests on equipments
7. Solve numerical problems regarding high voltage topics

Learning and teaching approach used

- Lectures : 2 hours per week.
- Tutorial : 1 hour per week.
- Self study : 6 hours per 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. 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%.

Subject matter

1. **Introduction:** Areas in which high voltages are used, Basic problem in dealing with high voltages.
2. **Conduction and Breakdown**: Basic processes of conduction, current growth, Theories of breakdown in gaseous, liquid, solid and vacuum insulation.
3. **Insulation Design Principles:** Types of insulating materials - temperature classification, Factors affecting dielectric strength, Insulation design of rotating machines, transformers, transmission lines, switchgear etc.
4. **High Voltage measurement and Test Equipment:** High Voltage Measurement, Sphere gap and charging current method, H.V. Bridges for permittivity & loss angle measurement, Test equipment for AC, DC impulse, partial discharge, dielectric tests etc**.**
5. **High Voltage Testing of Electric Apparatus:** Significance of various tests, Examples of testing of insulators, bushings, transformer, cables, lightning arresters, etc.

Reading list

1. Naidu and Kamaraju (2009), "High Voltage Engineering", Tata McGraw Hill Publishing Company, New Delhi.
2. Wadha, C L (2007), "High Voltage Engineering", New Age International, New Delhi.

Date: 3 June 2011

Name of the module	**:**	Communication Engineering
Module Code	**:**	COM401
Semester	**:**	VIII
Credit Value	**:**	12
Module Leader	**:**	Mrs. Karma Kezang Eudon
Module Tutor	**:**	Mrs. Karma Kezang Eudon and Mrs Sonam Peden

General Objectives:

This module will familiarize students with the concept of Electronics Communication Engineering that is essential for Electrical Engineering at BE level. And develop basic analytical understanding of Communication Engineering and its applications in the field of Information transfer from source to a information Sink.

Learning Outcomes

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

1. Perform basic signal operations on analog signals
2. Compute frequency spectrum for real time signals
3. Analyze the analogue signals in time domain and frequency domain
4. Identify the basic elements of communication systems
5. Differentiate mathematically and physically between AM, FM and PM
6. Implement AM, PM and FM modulators and Demodulators
7. Implements frequency domain analysis of base band line codes with its PSD
8. Differentiate mathematically and physically between ASK, BFSK , BPSK, QPSK and QAM
9. Implement ASK, BFSK , BPSK, QPSK and QAM modulators and Demodulators
10. Draws constellation diagrams and understand its applications
11. Explain multiplexing and applies the concept of TDM and FDM on physical systems
12. Explain information and amount of information
13. Calculate the entropy of a digital source and compares the efficiency of line codes
14. Defines Characteristics impedance for balanced and un-balanced transmission lines and understands impedance matching
15. Explain the fundamentals of Antennas and electromagnetic radiations.

Learning and Teaching Approach used:

- Lecture : 3 hours per week
- Laboratory Practical : 2 Hours per week
- Self study : 7 hours per week

Assessment:

- **Theory – 75 marks**
  Continuous assessment 25 marks
  7. Assignment - 10marks

8. Closed book mid Term Test - 10marks
9. Class Test - 5marks

Semester End Examination – 50 marks

3. Written examination (Closed books): 3 hours.

- **Practical continuous Assessment - 25 Marks**
  5. Regular Laboratory work – 15 marks as shown in annexure - I
  6. 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%.

Pre-requisite : Engineering Mathematics-IV and Electronics-I

Subject matter:

1. **Continuous wave modulation:** Elements of communication system and its limitation, motivation for modulation, Time and Frequency domain representation of signals, Amplitude modulation and detection, Suppressed Carrier modulation, Single Side Band Modulation and detection, Vestigial Side Band Modulation, Phase Modulation, Frequency Modulation, Wide band and narrow band frequency modulation, FM detection, Stereophonic FM, Frequency Division Multiplexing, Thermal Noise and short noise; noise in communication systems.
2. **Pulse Modulation:** Base band signal characterization, Sampling Theorem, Signal reconstruction in time domain, Practical and Flat Top sampling, Sampling of band pass signals, Analog pulse modulation systems, Pulse Amplitude Modulation, Pulse Position Modulation and Pulse width Modulation.
3. **Waveform coding Techniques:** Discretisation in time and amplitude, Quantization – uniform and non uniform, Quantization Noise, Encoding and Pulse code Modulation, Binary and M' ary systems, BW requirement of PCM, Differential Pulse code Modulation, Delta Modulation and detection, Coding speech at low bit rates.
4. **Time Division Multiplexing:** Fundamentals, Electronic commutator, bits/byte interleaving, TI carrier system synchronization and signalling of T1, TDM, PCM hierarchy, synchronization Techniques.
5. **Digital Modulation Techniques:** Types of Digital Modulation, Wavforms for Amplitude, Frequency and Phase shift keying. Methods of generation and detection of coherent and non coherent ASK, FSK and PSK, Probability of error, comparison of above digital Modulation Techniques.
6. **Introduction to Information Theory:** Measure of information, Entropy and Information rate, Channel capacity, Hartley Shannon law, Huffman coding, Shannon – Fano coding.
7. **Micro Lines and Components:** Transmission line, balanced – unbalanced, characteristic impedance, propagation constants, impedance matching, skin depth, $\lambda/4$, $\lambda/2$ lines and dipole antenna, antenna gain, antenna directivity and antenna pattrns, Horn, yagi- uda, parabolic reflector type antennaes, microwave wave guides and associated wave guide components.

List of Practicals:

1. To study wave form and spectrums of AM Modulator and Demodulator
2. To study wave form and spectrums of FM Modulator and Demodulator
3. To study working of Super heterodyne Radio receive
4. To study wave form and spectrums of PCM Modulator and Demodulator
5. To study Time Division Multiplexing
6. To study Frequency Division Multiplexing
7. To study wave form and spectrums of ASK, PSK and FSK Modulator and Demodulator
8. To measure frequency of Micro wave using sliding type frequency meter.
9. To study the effect of medium on the transmission / reception of micro waves.
10. To study wired and wireless communication systems
11. To calculate the characteristic impedance of a transmission line

Reading List:

1. Haykins Simon (2009) , "An Introduction to Analog and Digital Communication systems", 4th edition, John Wiley & Sons, New Delhi.
2. CouchII W Leon (2004), "Digital and Analog Communication System Pearson Education", 6th edition, New Delhi.
3. Couch W Leon (2004), "Modern Communication Systems: Principle and applications", 2nd edition, Prentice Hall of India, PHI Private Limited, New Delhi.
4. Miller M Gary and Beasly S Jeffrey (2002), "Modern Electronic Communication", 7th edition, Prentice Hall of India, PHI Private Limited, New Delhi.
5. Haykins S S (2004), "Digital Communications", John Wiley & Sons, Singapore, Student Edition
6. Carlson Bruce A (2002), "Communication Systems An introduction to Signal and noise in Electrical communication", 4th edition, McGraw Hill Book Company, New Delhi.
7. Kennedy G and Davis B (2003), "Electronic Communication Systems", 4th edition, Tata McGraw Hill, New Delhi.
8. Tomasi Wayne, (2004), "Electronic Communication System Fundamental through Advanced", 5th edition, Pearson Education, New Delhi.
9. Lathi B P (2002), "Modern Analog and Digital Communication", 4th edition, John Wiley & Sons, New Delhi.
10. Simon Haykins (2004), "Communication Systems", John Wiley & Sons
11. Taub & Schilling (1998), "Principles of Communication Systems", 4th edition, Tata McGraw Hill, New Delhi.
12. Liao Samuel Y (2006), "Microwave Devices and Circuits", 3rd edition, Prentice Hall of India, PHI Private Limited, New Delhi.

Date: 3 June 2011

Name of the Module	**:**	Project
Module Code	**:**	PRW401
Semester	**:**	VIII
Credit Value	**:**	18
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	**All faculty**

General objectives or aims of the module:

To organize the necessary steps required in the complete execution of the project work.

Learning outcomes:

At the end of this module, students are expected to 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 skills in the student.

- Self Study : 16 hours per week

Assessment

The final year project work evaluation is in three parts as shown below. Out of a total of 100 marks, 50 marks are allocated for regular work, 20 marks for project report evaluation and 30 marks for end semester examination. The detail marking scheme is shown in Table 2.

Subject matter: This will depend on student's interest and guide expertise. The final report must be as per the format set by the College.

Reading list:

Current research topics from research magazines

Table – 2: Project Marking Scheme

Areas to be evaluated			Marks
CA			**70**
1	**Regular Work [By project guide(s)]**		**60**
	i	Actual work involvement	10
	ii	Team sprit & work culture	5
	iii	Conceptual understanding	5
	iv	Analysis & interpretation capability	10
	v	Literature Review	5
	vi	Planning & execution/ compliance in carrying out guides instruction	5
	vii	Time Management	5
	viii	Technical writing skills	10
	ix	Conference paper writing	5
2	**Mid Term Review**		**10**
Semester End			**30**
3	**Report Evaluation**		**10**
	i	Theme of the project/ originality of the idea	2
	ii	Realisability/ Practicality	1.5
	iii	Format & presentation/description style	1
	iv	Abstract/ Introduction	0.5
	v	Reasons for specific mode of implementation	1.5
	vi	Information content	2
	vii	Conclusion/ analysis & finding	1.5
4		**Presentation**	**20**
	i	Introduction	2
	ii	Presentation Techniques	2
	iii	Content	2
	iv	Language	2
	v	Confidence	2
	vi	Response to questions	10
	Total Marks		**100**

Date: 3 June 2011

Name of Module	:	On the Job Training
Module Code	:	OJT401
Semester	:	VIII
Credit value	:	0
Module Leader	:	Mr. Roshan Chhetri
Module Tutors	:	Mr. Ugyen Tenzey and Mr. Roshan Chhetri

General objectives or aims of the module:

The purposes of the attachment program is to gain practical experience from a real industrial environment and instill in the students the right kind of work attitude and work professionalism, so that they can become effective and productive to their respective organizations much sooner than is usual for fresh graduates.

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 7^{th} 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 (Refer to annexure II for detail mode of assessment)

Subject Matter:

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.

Documentation of Innovative Details: Documentation of innovative details from personal observations, office records or field studies. Critical observations of performance, usefulness etc

Field Observation: Observe, record and analyse the observations and to draw lessons from the study of any particular aspect.

Office Training: Students are required to be involved in all aspects of office work

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: 3 June 2011

Elective - II

Name of the Module	**:**	Computer Methods in Power Systems
Module Code	**:**	PSS405
Semester	**:**	VIII
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mr. Roshan Chhetri and Mr. Cheku Dorji

General objectives or aims of the module:

This module will familiarize students with the computer methods involved in the major power system analysis processes such as short circuit studies and load flow analysis. And develop power system analysis process in terms of network matrices.

Learning outcomes:

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

1. Use the inspection and algorithm approaches to formulate the bus impedance and admittance matrices.
2. Use algorithmic approaches to modify the network matrices in branch or loop frame of reference.
3. Utilize the sparsity involved in Y-bus for implementing iterative load flow methods.
4. Utilize Z-bus for a fixed solution to the short circuit problem rather than iterative methods.

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. 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.

- Lectures : 3 hours per week
- Computer based simulation session : 1 hour per week
- Self study : 6 hours per week

Assessment:

Continuous Assessment - 30 marks (30%)

4. Assignment - 10marks
5. Closed book mid Term Test- 15marks
6. Class Test - 5marks

Semester End Examination - 70marks (70%)

7. 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: Power System Analysis

Subject matter:

1. **Network Matrices Formulation:** Algorithms for formation of Impedance and admittance matrices in bus and loop frame of reference; Modification of network matrices for changes in network; Examples of formation & modification of bus impedance and admittance matrix.
2. **Three Phase Networks:** Three phase balanced network elements; Transformation matrices; Positive sequence representation of 3-phase balanced network; 3-phase unbalanced network elements; Incidence and network matrices for 3-phase networks; Algorithms for formation of 3-phase Bus impedance matrix; Example of formation of Z bus.
3. **Short Circuit Studies:** Short circuit calculations for balanced 3-phase network using Z-bus_abc, Examples of short circuit calculations using Z-bus for L-L-L and L-G, L-L, L-L-G faults.
4. **Sparsity Technique in Load Flow Studies:** Sparsity technique for Y-bus and Gauss-Seidel method; Review and comparison of GS, NR, FDC models.
5. **Transient Stability Analysis:** Representation of transmission networks; Generators and loads - Exciter and governor control system representations; Numerical integration methods, Runge kutta second and forth order methods and modified Euler's method; Digital simulation of fully controlled single machine infinite bus system; Stability studies of multi machine systems based on constant flux linkages.
6. **State estimation:** Linear state estimation equations, types of measurements; D.C power flow based WLS equations; Examples of D.C based WLS state estimation; Introduction to Automatic Generation control.

Reading list:

1. G.W. Stagg and A.H. El-Abiad (1962), "Computer Methods in Power system Analysis", McGraw Hill Ltd. New York.
2. M.A. Rai, "Computer Techniques in Power System Analysis", Tata McGraw Hill.
3. J. Arrillage and C.P. Arnold, "Computer Analysis of Power Systems", John Wiley and sons.
4. A.R. Gergen, "Power system Analysis", Prentice hall Inc.
5. Kusic G L (2005), "Computer Aided power System Analysis", Prentice Hall of India. New Delhi.
6. A.K. Mahalanabis, D.P. Kothari and S.I. Ahson, "Computer Aided Power System Analysis and Control", TMH, New Delhi.
7. C.S. Indulkar and D.P. Kothari, "Power System Transients: A Statistical Approach", PHI, New Delhi.
8. Hadi Sadat (2004), "Power System Analysis", Tata Mc Graw Hill Publishing Company Ltd, New Delhi.

Date: 3 June 2011

Name of the Module	**:**	Artificial Neural Networks
Module Code	**:**	PSS406
Semester	**:**	VIII
Credit Value	**:**	12
Module Leader	**:**	Dr. Andu Dukpa
Module Tutor	**:**	Dr. Andu Dukpa

General objectives or aims of the module:

To familiarize students with the basic neuro-science and its use in the characterization of artificial software tools that can perform complex non linear mapping.

Learning outcomes:

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

1. Recognize the artificial processing elements that can be utilized as building blocks for the ANN implementation systems.
2. Practice non-linear mappings through different neural network structures.
3. Employ the Neural systems for various applications.

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. 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.

- Lectures : 3 hours per week
- Computer based simulation session : 1 hour per week
- Self study : 6 hours per week

Assessment:

Continuous Assessment - 30 marks (30%)

7. Assignment - 10marks
8. Closed book mid Term Test- 15marks
9. Class Test - 5marks

Semester End Examination - 70marks (70%)

8. 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%.

Subject matter:

1. **Fundamentals:** Introduction and motivation; Basics of Neuroscience; Biological neural networks and simple models; Artificial Neuron Models; Graphs Algorithms; Inter connection and routing; Placement and partitioning / parallel Computation; Associative memory.
2. **Networks:** Perceptrons and Threshold logic machines; Hopfield nets; Energy function and Optimization; Multi-layer networks, training, Feed Forward Networks, Unsupervised and reinforcement learning. Adaptive structure networks, Recurrent networks, Competitive learning and self organising Networks, Unsupervised competitive learning, Adaptive resonant networks, Hybrid Learning, Radial basis Function Networks (RBF) and Time Delay Networks (TDNNs).
3. **Applications:** Hardware and implementation concerns, approach to solving Hard problems, multitarget Tracking, Time series Prediction, Handwritten digit recongnition, Image compression, Visual processing Networks.

Reading list:

1. N K Bose & P Liang (2004), "Neural Networks Fundamentals with Graphs, Algorithms and Applications", TMH, New Delhi.
2. Limin Fee, "Neural Networks in Computing intelligence", TMH
3. Koskop, "Neural Networks and Fuzy System: A Dynamical systems approach to Machine Intelligence", PHI
4. Mohamad H. Hassoum (2002), "Fundamentals of Artificial neural networks", PHI eastern economy edition.
5. B. Yegnanarayana (2001), "Artificial Neural Networks", PHI eastern economy edition, New Delhi.

Date: 3 June 2011

Name of the Module	**:**	EHV AC/DC Transmission Engineering
Module Code	**:**	PSS408
Semester	**:**	VIII
Credit Value	**:**	12
Module Leader	**:**	Dr. Andu Dukpa
Module Tutor	**:**	Dr. Andu Dukpa and Mr. Roshan Chhetri

General objectives or aims of the module:

The module will introduce students to EHV AC/DC transmission Systems and control of power flow. The module also provides base for advanced power system engineering.

Learning outcomes:

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

1. Describe the need of EVH transmission lines, power handling capacity, surge impedance loading and problems of EHV transmission systems
2. Explain bundled conductors: geometric mean radius of bundle, properties of bundle conductors in EHV transmission systems and their calculations
3. Explain EHV transmission line electrostatic fields, corona effects, corona loss, audio radio noises, their effects and calculations, and control of active and reactive power flow.
4. Describe turbine-speed governing system, speed-governing characteristic of generating unit, parallel operation of generators, elements of load frequency control: Flat frequency, flat tie line and tie line load bias control.
5. Explain automatic generation control (description of block diagram only), no-load receiving end voltage, reactive power generation and methods of voltage control: - Synchronous phase modifier, shunt capacitors and reactors, saturable reactors, thyristorised static VAR compensators.
6. Analyze and explain basic features of FACTS controllers, basic scheme and operation of thyristor controlled series compensators phase angle regulator, dynamic brake, static synchronous compensator (STATCOM), unified power flow controller (UPFC) and application of FACTS controllers to power systems.
7. Explain types of DC links: Mono-polar, bi-polar and homo-polar DC links, basic scheme and equipment of converter station, ground return, basic principles of DC link control and basic converter control characteristics.
8. Explain to multi-terminal HVDC systems and explain application of HVDC transmission systems.

Learning and teaching approach used

- Lectures : 3 hours per week.
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment:

Continuous Assessment - 30 marks (30%)

10. Assignment - 10marks

11. Closed book mid Term Test- 15marks
12. Class Test - 5marks

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%.

Subject matter:

1. **EHV AC Transmission:** Need of EVH transmission lines; Power handling capacity, surge impedance loading and problems of EHV transmission systems; Bundled conductors: geometric mean radius of bundle, properties of bundle conductors in EHV transmission systems; Electrostatic fields of EHV lines and their effects; Corona effects, corona loss, audio and radio noises in EHV transmission lines.
2. **Load Frequency Control:** Introduction to control of active and reactive power flow; Turbine-speed governing system, speed-governing characteristic of generating unit and parallel operation of generators; Elements of load frequency control; Flat frequency, flat tie line and tie line load bias control; Automatic generation control (description of block diagram only)
3. **Voltage Control:** No-load receiving end voltage and reactive power generation; Methods of voltage control: -Synchronous phase modifier, shunt capacitors and reactors, saturable reactors, thyristorised static VAR compensators.
4. **FACTS:** Problems of AC transmission systems; Introduction to FACTS (Flexible AC Transmission System) Controllers; Basic features of FACTS controllers; Basic scheme and operation of thyristor controlled series compensators phase angle regulator and dynamic brake; Introduction to static synchronous compensator (STATCOM), and unified power flow controller (UPFC); Application of FACTS controllers to power systems.;
5. **HVDC Transmission:** Types of DC links: Mono-polar, bi-polar and homo-polar DC links; Advantages and disadvantages of HVDC transmission; Basic scheme and equipment of converter station, and ground return; Basic principles of DC link control and basic converter control characteristics; Introduction to multi-terminal HVDC systems; Application of HVDC transmission systems.

Reference books

1. B. R. Gupta (2002), “Generation of Electrical Energy”, S. Chand and Company Limited, New Delhi.
2. R.D.Begamudra (1997), “EHV AC Transmission Engineering”.
3. Soni, Gupta and Bhatnagar, ”Electrical Power Systems”, Dhanpat Roy and Sons Publishers, New Delhi.
4. J.J Grainger and WD Stevension (1982), “Power system Analysis”, Mc Graw Hill, New York.
5. K.R.Padiyar, “Flexible AC Transmission Systems-A status review, Summer School on ‘Recent Advances in Power Electronics’, August 10-21,1998, IISc Bangalore, Page 10.1 to 10.16”.

6. I. J. Nagrath and D.P. Kothari (2003), “Power System Engineering”, Tata Mc Graw Hill, New Delhi
7. A. Adris (2000), “FACTS Technology Development: An Update, IEEE Power Engineering Review, March 2000, pp 4 to 9”.

Date: 3 June 2011

Name of the Module	**:**	Testing and Commissioning of Electrical Machines
Module Code	**:**	EMC402
Semester	**:**	VIII
Credit Value	**:**	12
Module Leader	**:**	Mr. Cheku Dorji
Module Tutor	**:**	Mr. Cheku Dorji and Mr Sonam Norbu

General objectives or aims of the module:

This module will develop the broad concepts on the standard installation procedures of Electrical machines and detail concepts on standard testing procedures and on various tests required to be performed on the Electrical machines.

Learning outcomes:

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

Transformers:

1. Describe installation - Location and site, foundations, code of practice for terminal plates, polarity and phase sequence, Oil tanks, Drying of windings with and without oil
2. Discuss and use general inspection procedures for electrical machines.
3. Explain commissioning Tests - Voltage ratio, Earthing resistance, Oil strength, Buchholz and other relays, Tap changing gear, Fans and pumps; Insulation test, Impulse test, Load and temperature rise tests
4. Analyse specific Tests - Determine performance curves and efficiency.

Induction Motors:

1. Describe installation - Location of motor and control apparatus, foundation and levelling, Shaft alignment for various coupling, Drying out of windings
2. Explain commissioning Tests - Mechanical tests for alignment, air gap symmetry bearings, vibrations and balancing. Electrical Tests: Insulation test, earthing, High voltage test, starting up, Ability to speed up and to take load.
3. Classify Type and Routine Tests - In accordance with I.S.I. Test Code.
4. Analyse specific Tests - Performance and temperature rise tests, Stray load losses, and shaft currents
5. Explain maintenance schedule and apply to the extent possible.

Synchronous Machines:

1. Describe installation: Physical inspection and alignment check, excitation system, cooling and control gear, Drying out.

2. Explain commissioning Tests - Insulation resistance, Resistances of armature and field windings, Polarity and Phase sequence, shaft currents, Wave form and telephone interference factor, over speed tests, and Line charging capacity
3. Estimate performance Tests - Various tests to estimate the performance for generator and motor operation, sudden short circuit test and transient & sub-transient parameters, and measurement of sequence test
4. Apply factory Tests - Gap length, Magnetic circuitry, Balancing, Vibration, Bearing currents, and Electrical Tests.

Learning and teaching approach used

Most commonly chalk and talk method is used. This supplemented by OHP transparencies, pre-prepared handouts, practical demonstrations in the actual field, tutorials, personal interactions etc

- Lectures : 3 hours per week
- Tutorial : 1 hour per week
- Self study : 6 hours per week

Assessment:

Continuous Assessment - 30 marks (30%)

13. Assignment - 10marks
14. Closed book mid Term Test- 15marks
15. Class Test - 5marks

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%.

Subject matter

1. **Transformers:** Installation - Location and site, foundations, code of practice for terminal plates, polarity and phase sequence, Oil tanks, Drying of windings with and without oil; General inspection; Commissioning Tests - Voltage ratio, Earthing resistance, Oil strength, Buchholz and other relays, Tap changing gear, Fans and pumps; Insulation test, Impulse test, Load and temperature rise tests; Specific Tests - Determination of performance curves, efficiency.
2. **Induction Motors:** Installation - Location of motor and control apparatus, foundation and levelling, Shaft alignment for various coupling, Drying out of windings; Commissioning Test - Mechanical tests for alignment, air gap symmetry bearings, vibrations and balancing. Electrical Tests: Insulation test, earthing, High voltage test, starting up, Ability to speed up and to take load; Type and Routine Tests - In accordance with I.S.I. Test Code; Specific Tests - Performance and temperature rise tests, Stray load losses, shaft currents; Maintenance schedule.
3. **Synchronous Machines:** Installation: Physical inspection and alignment check, excitation system, cooling and control gear, Drying out; Commissioning Tests - Insulation resistance, Resistances of armature and field windings, Polarity and Phase

sequence, shaft currents, Wave form and telephone interference factor, over speed tests, Line charging capacity; Performance Tests - Various tests to estimate the performance for generator and motor operation, sudden short circuit test and transient & sub-transient parameters, measurement of sequence test; Factory Tests - Gap length, Magnetic circuitry, Balancing, Vibration, Bearing currents, Electrical Tests.

Reading List:

1. Electrical Hand books by different publishers,
2. Related I.S.Codes.

Date: 3 June 2011

Name of the Module	: Introduction to Robotics
Module Code	: SAS402
Semester	: VIII
Credit Value	: 12
Module Leader	: TBA
Module Tutor	: TBA

General objectives or aims of the module:
Fundamentals of robotics, rigid motions, homogeneous transformations, forward and inverse kinematics, velocity kinematics, motion planning, trajectory generation, and control.
Learning outcomes:
At the end of the module, students are expected to be able to:

- Be familiar with Denavit-Hartenberg convention.
- Be familiar with Lagrange-Euler formulation.
- Be able to control a robotic manipulator effectively by computer simulation.
- Be familiar with the computer simulation skills associated with robotic control.
- Be able to use FFT to analyze the link vibration from the robotic links.

Learning and teaching approach used

Most commonly chalk and talk method is used. This supplemented by OHP transparencies, pre-prepared handouts, practical demonstrations in the actual field, tutorials, personal interactions etc

Lectures: 3 hours per week
Tutoring: 1 hour per week
Self study: 4 hours per 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%)

3 hrs written examination (closed book)

Subject matters:

1. Introduction: Historical development of robots; basic terminology and structure; robots in automated manufacturing
2. Rigid Motions and Homogeneous Transformation: Rotations and their composition; Euler angles; roll-pitch-yaw; homogeneous transformations; Matlab and Mathematica code for symbolic and numerical computation
3. Forward Kinematics: Common robot configurations; Denavit-Hartenberg convention; A-matrices; T-matrices; examples
4. Inverse kinematics: Planar mechanisms; geometric approaches; spherical wrist
5. Velocity kinematics: Angular velocity and acceleration; The Jacobian; singular configurations; singular values; pseudoinverse; manipulability
6. Motion planning: Configuration space; artificial potential fields; randomized methods; collision detection
7. Trajectory generation: Joint space interpolation; polynomial splines; trapezoidal velocity profiles; minimum time trajectories
8. Feedback control: Actuators and sensors; transfer functions; tracking and disturbance rejection; PID control; feed forward control; resolved motion rate control.
9. Linear control of manipulators: second-order linear systems, damping ratio, natural frequency, control-law partitioning (model-based portion, servo portion), trajectory-following control, disturbance rejection, modeling and control of a single joint.
10. Nonlinear control of manipulators: nonlinear and time-varying systems, multi-input, multi-output control systems, Lyapunov stability analysis.

Reading list

4. Murray, Richard M., Li, Zexiang, Sastry, S. Shankar, "A Mathematical Introduction to Robotic Manipulation", CRC Press, New York.
5. Fu, K. S., Gonzalez, R. C., Lee, C. S. G., "Robotics – Control, Sensing, Vision, and Intelligence", McGraw-Hill International Edition, 1975.
6. Craig, John J., "Introduction to Robotics Mechanics and Control," 3rd Edition, Pearson Prentice Hall, ISBN 0-13-123629-6.

Date: Feb. 1st, 2011

Name of Module	:	Organizational Behavior
Module Code	:	MGT404
Semester	:	VIII
Credit value	:	12
Module Leader	:	Mr. Nima Dukpa
Module Tutor	:	Mr. Nima Dukpa

General objectives:

To provide an understanding of different psychological and social perpective and methods used in studying Organisational Behavior and to develop critical awareness of the theoretical approaches to study of individual differences. To encourage students to research how these concepts and principles are being applied in actual organization.

Learning outcomes:

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

1. Identify and explain the different and competing perspectives of organizational behaviour.
2. Compare and contrast the main theoretical approaches to individual behaviour
3. Describe and interpret relevant factors affecting people's behaviour in the workplace
4. Relate the theoretical knowledge to practice in work in organizations via self directed and collaborative learning.

Learning and teaching approach used:

Formal lectures will be held on a weekly basis. They will provide an introduction to the main theoretical perspectives in OB managerial and organizational practices. Group discussions, case studies will strengthen the key topics in depth. Students will be encouraged to collect their own portfolio of contemporary business practice in OB which will be a non-assessed supplement to the formal assessment.

- Lecture : 3 hours per week
- Tutorial : 0 hour per week
- Self study : 5 hours per week

Assessment

Continuous Assessment - 50 marks

(Assignment – 50%. One assignment of 2500 words essay to be selected from a choice of 4-6 tropics, and to be submitted in week 8. This strategy is designed to allow students the opportunity to examine an area of interest from the syllabus and allows students to research ahead of the lecture program, if they wish. Oral Presentation: 50%)

Semester End Examination – 50 marks

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%.

Subject matter:

1. Introduction to Organizational Behaviour
2. Perception and Learning: Understanding and Adapting to the work environment
3. Individual differences: Personality and Abilities
4. Emotions and stress at work
5. Work related attitudes: feeling about jobs, organizations and people.
6. Motivation in organizations by meeting needs, setting goals, being fair, alerting expectations and structuring jobs to make them interesting.
7. Group Dynamics: Group Processes and Work teams, communication, decision making, organization culture, creativity and innovation.
8. Organizational structure: Organizational structure and design.
9. Conflict management: Sources of conflict, types of conflict, conflict resolution strategy.

Reading list:

1. Greenberg Jerald and Baron Robert A, (2005), "Behavior in Organizations", 8th edition, Prentice Hall of India.
2. Robbins Stephen P, (2004), "Organizational behavior", 10th edition, Pearson Education.

Date: 3 June 2011

Name of the Module	**:**	Electrical Machine Design
Module Code	**:**	EMC403
Semester	**:**	VI
Credit Value	**:**	12
Module Leader	**:**	Mr. Roshan Chhetri
Module Tutor	**:**	Mr. Cheku Dorji

General objectives or aims of the module:

This module will introduce the basic concepts of the properties of electrical engineering materials, magnetic circuits and cooling of rotating electrical machines. And develop the basic concepts on the main design features of transformers, induction machines and synchronous machines.

Learning outcomes:

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

1. Review machine ratings, temperature rise, time curves
2. Derive and apply the expression for the Quantity of cooling medium for air, hydrogen and water.
3. Explain the properties of conducting materials - electrical conductivity, density, resistivity, Mechanical strength, reliability, drawability, solderability, resistance to corrosion and thermal conductivity.
4. Relate the influence of cost and availability of conducting materials on their use.
5. Compare the properties and cost of Aluminium, copper, iron and steel and their alloys used in electrical Engineering.
6. Calculate total mmf, mmf in air gap, net length of iron
7. Explain real and apparent flux density, effects of leakage and saturation.
8. Determine main dimensions of transformer, induction machines and synchronous machines.
9. Design of core, yoke, winding and cooling tubes of transformers.
10. Derive output equations of transformer and induction machines
11. Compute average flux densities in air gap
12. Design of rotor and stator slots for slip ring and cage type motors
13. Compute magnetising currents
14. Design armature winding.
15. Enlist and discuss the effects of air gap and harmonics on the design of synchronous machines.

Learning and teaching approach used

Most commonly chalk and talk method is used. This supplemented by OHP transparencies, pre-prepared handouts, practical demonstrations, tutorials, personal interactions etc

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

- Self study : 6 hours per week.

Assessment

Regular questioning, two phase tests, class test, assignments, and terminal examinations.

Continuous Assessment - 30 marks (30%)

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

Semester End Examination - 70marks (70%)

4. 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: Electrical Machines – I and Electrical Machines – II

Subject matter

1. **Cooling of Rotating Electric Machines:** Ratings, temperature rise, time curves; Cooling methods, cooling circuits, air, hydrogen and water cooling, direct cooling; Quantity of cooling medium for air, hydrogen and water.
2. **Electrical Engineering materials – review:** Properties of conducting materials, electrical conductivity, density, resistivity; Mechanical strength, reliability, drawability, solderability; Resistance to corrosion; Thermal conductivity, cost, etc.; Aluminium, copper, iron and steel and their alloys used in electrical Engineering.
3. **Magnetic Circuits:** Calculation of total mmf, mmf in air gap, net length of iron; Real and apparent flux density, effects of leakage and saturation.
4. **Transformers:** Determination of main dimension; Design of core, yoke, winding and cooling tubes.
5. **Induction Machines:** Output equation; Average flux densities in air gap; Main dimension; Design of rotor and stator slots for slip ring and cage type motors; Magnetising currents; Design of armature winding.
6. **Synchronous Machines:** Calculation of main dimensions; Short circuit ratio and its influence on the design; Air gap, harmonics and its effects on the design; Elimination of harmonics.
7. **Vibration of Electrical rotating machine**:

Reading list:

1. A K Sawhney (2004), "A course in Electrical Machine Design", Khanna Punlishers
2. Clayton and Hancock, "Performance and Design of DC Machines", Khanna Punlishers
3. M G Say (2002), "Performance and Design of DC Machines".

Date: **3 June 2011**

Name of the Module	:	Power System Operation and Control
Module Code	:	PSS408
Semester	:	VIII
Credit Value	:	12
Module Leader	:	TBA
Module Tutor	:	TBA

General objectives or aims of the module:
The module will offer an overview of power system operation and control in order to understand modern power system control strategies including Energy Management System and SCADA.

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

9. Explain the need for power system operation and control.
10. Describe the importance of economic operation of power system, including optimal power flow and unit commitment.
11. Explain Automatic Generation Control (AGC) and voltage control, including various control strategies adopted.
12. Describe reactive power control and various control strategies.
13. Describe the importance of computer control in power system including SCADA and Energy management systems (EMS) in power systems.

Learning and teaching approach used

Lectures	:	3 hours per week.
Tutorial	:	1 hour per week
Self study	:	6 hours per week

Assessment

- **Continuous assessment - 30 marks**
  1. Assignments : 5 marks
  2. Class Tests (two class tests) : 5 marks each
  3. Mid-term test : 10 marks

- **Semester End Examination - 70marks**
  Semester End Examination (closed books, 3 hours): 70 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. Introduction

Background; the basic objectives of security and economics in power system operations and

control; Role of the energy management system (EMS); Overview of system control: Governor control, LFC, EDC, AVR, system voltage control, security control.

2. Economic Operation

Introduction to Unit commitment; Optimal operation of thermal units; Penalty factor; incremental, transmission loss formula; Optimal power flow; Hydrothermal scheduling long and short terms

3. Automatic Generation Control:

Automatic voltage regulator; AVR control loops of generators, performance of AVR; automatic load frequency control, ALFC of single area systems; Concept of control area, multi-area systems, POOL operation-two area systems, tie-line bias control.

4. Voltage and Reactive Power Control:

Introduction; Voltage control methods; Compensation methods including phase angle compensation; generation and absorption of reactive power, relation between voltage, power and reactive power at a node; Single machine infinite bus systems; sub-synchronous resonance; Voltage stability, voltage collapse.

5. SCADA and Energy Management System

Energy control centre: Functions – Monitoring, data acquisition and control; SCADA and EMS functions: Remote terminal unit, Control centers, Communication sub-system, Control centers, Communication aspects, application.

Text and Reference Books

1. Olle. I. Elgerd, 'Electric Energy Systems Theory – An Introduction', Tata McGraw Hill Publishing Company Ltd, New Delhi, Second Edition, 2003.
2. Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2003.
3. P. Kundur, 'Power System Stability & Control', McGraw Hill Publications, USA, 1994.
4. D. P. Kothari and I. J. Nagrath, 'Modern Power System Analysis', Third Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
5. L.L. Grigsby, 'The Electric Power Engineering, Hand Book', CRC Press & IEEE Press, 2001.
6. J. J. Grainger and W. D. Stevenson, 'Power System Analysis', McGraw Hill, New York.
7. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill, 2002.
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Date: 4 June, 2011