2. Detailed Syllabus for B. Tech program in Energy Engineering

MA - 101: ENGINEERING MATHEMATICS - I **3-1-0 = 4**

Subject Code: *MA - 101.*
Subject Name: *Engineering Mathematics - I.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

UNIT -I

Differential Calculus of Single Variable: Functions, continuity and differentiability *(with emphasis on hyperbolic and inverse hyperbolic functions)***,** Properties of continuous functions on closed intervals, Intermediate value theorem and its applications, Successive differentiation ;Taylor's and Maclaurin's series; L'Hospital rule (statements only with applications)

UNIT-II

Complex analysis*:* Analytic functions, Cauchy-Riemann equations, Cauchy's integral theorem, Cauchy's integral formula, Taylor series and Laurent series. Residues and its applications to evaluating real integrals (statements only with applications).

UNIT- III

Laplace and Fourier Transforms: Laplace transforms, Inverse transform. Shifting on the *s* and ***t*** axes, convolutions, partial fractions, Fourier transforms, Solutions of ordinary differential equations by Laplace and Fourier transforms.

UNIT- IV

Linear Algebra: Vector space over the field of real and complex numbers, subspaces, bases and dimension; Matrices and Linear Transformation; Elementary row and column operations; echelon form; normal form; system of linear equations; eigen values and eigen vectors; Cayley-Hamilton theorem; diagonalization.

Text Books:

1. E. Kreyszig, "Advance Engineering Mathematics", 8th Ed, J. Willey & Co, 1999.
2. Spiegel, "Fourier Analysis with application & Laplace Transforms", Tata McGraw-Hill 2000.
3. S. Pal and S. C. Bhunia, "Engineering Mathematics'' , Oxford University Press, 2015.
4. B.S. Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna Publication 2015

Reference Books:

1. Babu Ram, "Engineering Mathematics", Pearson.
2. Sastry, "Engineering Mathematics", PHI.
3. M. C. Potter, J. L Goldberg and E.F. Aboufadel, "Advance Engineering Mathematics" (Third Edition),Oxford University Press

PH – 102: ENGINEERING PHYSICS - I **3-1-0 = 4**

Subject Code: *PH - 102.*
Subject Name: *Engineering Physics - I.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit-I: Classical mechanics and General properties of matter

Co-ordinate system: Cartesian, plane polar and Spherical polar coordinate system, Relationship between the coordinate system, velocity and acceleration in plane polar and spherical polar coordinate systems. Dimension analysis. Theory of Errors. Moment of inertia: Theorems of parallel and perpendicular axes. Compound pendulum and its theory. Elasticity: Interrelation of elastic constants. Torsion of a cylinder.

Unit-II: Optics

Interference: Concept of Interference, types of interference, Young's double slit experiment, Newton's ring experiment: Theory and application, Diffraction: Fraunhofer diffraction at a single slit, diffraction grating. Fresnel diffraction, zone plate. Polarization: Types of polarization. Nicol prism as polarizer and analyzer, half wave plate and quarter wave plate and applications.

Unit-III: Atomic, molecular and nuclear Physics

Rutherford model , Bohr model and Sommerfeld model of hydrogen atom. Vector atom model; Spectra of hydrogen atom. Concept of a molecule, molecular spectra, Raman effect. Nuclear binding energy. Nuclear reaction and Q-value, Nuclear fission, chain reaction, concept of a nuclear reactor, nuclear fusion and stellar energy.

Unit-IV: Electromagnetism

Electric field intensity and electric potential and the relation between them, Gauss law, Lorentz force, Biot-Savart law, Ampere's law, Faraday law, Maxwell's equation, Electromagnetic (e. m.) wave equation, solution of e. m. wave, transverse nature of e. m. wave

Text Books:

1. P K Chakrabarthy, Mechanics and General Properties of Matter, Books & Allied Ltd., 2001
2. B B Laud, Electromagnetics, 2/e, New age international, 1997
3. A Beiser, Concepts of Modern physics, Tata McGraw Hill, New Delhi, 1997
4. H K Malik and A K Singh, Engineering Physics, Tata McGraw Hill, New Delhi, 2010.

Reference Books:

1. F W Sears, M W Zemansky and H D Young, University Physics, Narosa Publishing House, 1982
2. G R Fowles and G L Cassiday, Analytical Mechanics, 7/e, Ceingage Learning, Indian Edition, 2005.
3. P V Naik, Principles of Physics, Prentice Hall of India Pvt. Ltd., 2000.
4. S G Lipson, H Lipson and D S Tannhauser, Optical Physics, Cambridge University Press, 1995

ES – 103: ELEMENTS OF ENVIRONMENTAL SCIENCE **2-1-0 = 3**

Subject Code: *ES - 103.*
Subject Name: *Elements of Environmental Science.*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Work = 30, End Semester Examination = 45.*
Questions to be set: *Six (Q.No 1 of 15 marks and Q.no 2 to Q.No 6 of 10 marks each).*
Questions to be answered: *Four (Q.No 1 Compulsory and any three from the rest).*
Duration of End Semester Examination: *Two and Half Hours*

Unit - I

Environment, ecosystems and biodiversity: Concept of environment*:* components ofenvironment and their interactions; abiotic and biotic factors; Ecosystems: characteristic feature and structure and function of forest, grassland, desert and aquatic ecosystem (Ponds, streams, lakes, rivers, oceans, estuaries); Ecological pyramid; energy flow and nutrient cycling; Biodiversity: value of biodiversity; loss and conservation of biodiversity

Unit - II

Environmental problems and issues: Environmental problems and issues: green house effect,ozone depletion, acid rain; Renewable and non renewable resources; natural resources, associated problem and its conservation: forest, water, mineral, food, energy and land resources; environmental impact assessment; environment protection act.

Unit - III

Environmental pollution and management: Environmental pollution: sources and types of air, water, soil, radioactive and noise pollution; Industrial pollutants and their impact on environment and human health; Toxicants and toxicity; toxic chemicals: heavy metals and pesticides; Safety and prevention of industrial pollution; bio-transformation and bioremediation;Aerobic and anaerobic treatment of waste water; waste management and cleanerproduction.

Text Books:

1. W. P. Cunningham, and W.B. Saigo, Environmental Science, McGraw Hill, New York, 1999.
2. E. P. Odum, and G. W. Barrett, Fundamentals of Ecology, Thomson Asia Pvt. Ltd.,Singapore, 2005.
3. E. Bacci, Contaminants in the Environment, CRC Press, 1994.
4. T. Ingold, The Perceptions of Environment, Routledge (Taylor and Francis Group), UK, 2000.

Reference Books:

1. N. J. Sell, Industrial Pollution Control: Issues and Techniques, Wiley Pub., 1992.
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2/E, PHI,1997.
3. Venugopal Rao, Textbook of Environmental Engineering, PHI, 2003.
4. S. S. Dara, A Text Book of Environmental Chemistry and Pollution Control, 7/E (revised), S. Chand and Co. Ltd., 2006.
5. C. Park, The Environment: Principles and Applications, Routledge (Taylor and Francis Group), UK, 2001.

HU- 104: PROFESSIONAL COMMUNICATION SKILLS **2-1-0 = 3**

Subject Code: *HU-104.*
Subject Name: *Professional Communication Skills.*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Work = 30, End Semester Examination = 45.*
Questions to be set: *Six (Q.No 1 of 15 marks and Q.no 2 to Q.No 6 of 10 marks each).*
Questions to be answered: ***F****our (Q.No 1 Compulsory and any three from the rest)*
Duration of End Semester Examination: *Two and Half Hours*

Unit I

General Principles of Communication and Oral Communication: The Process of Communication, Principles of Communication (communication barriers, levels of Communication, Communication network, verbal, non-verbal) and Professional Communication. The Speech Mechanism, IPA symbols (vowel and consonant sounds), minimal pairs, word transcription, stress and intonation, active listening, types of listening, traits of a good listener, active versus passive listening,

Unit II

Constituents of Effective Writing and Vocabulary:
The sentence and its parts, articles, the verb phrase, tense and aspect, the active and passive, the adjective, interrogative and negative sentences, concord, preposition. Paragraph development, summary writing and reading comprehension. Word formation processes: affixation, compounding, converting, use of words in different parts of speech, idioms and phrases.

Unit III

Business Correspondence and Communication Strategies:
Characteristics of Business Letters, Drafting: Bio-data/ Resume/Curriculum vitae (theory).
Report Writing: Structure, Types of Reports (theory). Presentation Skills, public speaking and group discussion (theory) and Soft Skills (theory).

Text Books:

1. Das, B. K., Samantray K., et.al., An Introduction to Professional English and Soft Skills, CUP, New Delhi, 2009.
2. Sharma R.C, Mohan K., Business correspondence and Report Writing, Tata Mcgraw Hill, New Delhi, 2002.
   Doff, A., Jones, C., Language In Use, Upper- Intermediate Classroom Book, Classroom Book, CUP, New Delhi, 2004.

Reference Books:

1. O'Connor, J. D., Better English Pronunciation, CUP, London, 2006.
2. Patnaik, P., Group Discussion and Interview Skills, CUP, New Delhi, 2011.
3. Greenbaum, Sidney, Oxford English Grammar, OUP, 1996.
4. Seely, John, Oxford Guide to Effective Writing and Speaking, OUP, India, 2000.
5. Eastwood, John, Oxford guide to English Grammar, OUP, India, 1994.

EN- 105: SOLID MECHANICS **3-1-0 = 4**

Subject Code: *EN-105.*
Subject Name: *Solid Mechanics.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Force Systems: Moment of a force about a point and about an axis; couple moment; reduction of a force system to a force and a couple. Equilibrium: Free body diagram; equations of equilibrium; problems in two and three dimensions; plane frames and trusses.

Unit II

Friction: Laws of Coulomb friction, problems involving large and small contact surfaces; square threaded screws; belt friction; rolling resistance. Properties of Areas: Moments of inertia and product of inertia of areas, polar moment of inertia, principal axes and principal moments of inertia.

Unit III

Kinematics and Kinetics of particles: Particle dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables; central force motion.

Unit IV

Rigid Body Dynamics: Relative velocity, Translation, Pure rotation and plane motion of rigid bodies, D'Alembert's principle, linear momentum, principle of conservation of momentum, Impact of solid bodies, work, energy, power, principle of conservation of energy.

Text Books:

1. R. K. Bansal, A textbook of Engineering Mechanics, Laxmi Publication, 1992.
2. I. H. Shames, Engineering Mechanics: Statics and Dynamics, 4/E, PHI, 1996.
3. F. P. Beer and F. R. Johnston, Mechanics for Engineering, TMH, 1987.
4. S. Ramamurtham, Engineering Mechanics, Dhanpatrai Publishing Company, 2003.

Reference Books:

1. R.C. Hibbler, Engineering Mechanics: Static, McMillan, 1998.
2. R.C. Hibbler, Engineering Mechanics: Dynamic, PHI, 1997.
3. K.L. Kumar, Engineering Mechanics, S. Chand, 1997.
4. Timoshenko and Young, Engineering Mechanics, McGraw Hill, 1956.
5. A.Nelson, Engineering Mechanics-Statics and Dynamics, McGraw Hill Publications, 2010.

HU – 114: DIGITAL ENGLISH LANGUAGE LABORATORY **0-0-4 = 2**

Subject Code: *HU – 114.*
Subject Name: *Digital English Language Laboratory.*
No. of Hours Per Week: *Practicals-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Practical Exercises:

1. Articulation and practice of Vowel sounds and Diphthongs.
2. Articulation and practice of consonant sounds.
3. Practice word and sentence stress with intonation.
4. Practice Oral Presentation skills.
5. Handling telephone calls.
6. Vocabulary practice through situational dialogues.
7. Reporting.
8. Debating.
9. Appearing for personal interview.
10. Writing E-mails.
11. Writing business letter.
12. Drafting Curriculum Vitae/ Resume/Biodata.
13. Using situational dialogues in situations like requests, asking and giving directions, leaving a message.

Resource Materials:–

A. *Books*:

1. Jones, Daniel, Cambridge English Pronouncing Dictionary with CD, New Delhi, 2009.
2. Cambridge Learners Dictionary with CD, CUP, New Delhi, 2009.
3. Rajeevan, Dutt, Sasikumar, A course in Listening and Speaking I and II with CD**,** CUP, New Delhi, 2007.
4. Rajeevan and Dutt, Basic Communication Skills, CUP, New Delhi, 2007.

B. Software: Orell Digital Language Lab Software.

EN – 116: ENGINEERING DRAWING **0-0-4 = 2**

Subject Code: *EN-116.*
Subject Name: *Engineering Drawing.*
No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Drawing Plates/Sheets:

1. Introduction of Drawing (*Sheet layout and Sketching, Lines, Lettering and Dimensioning).*
2. Geometrical Constructions (*Bisecting a lines, Perpendicular lines, divide a lines, Construction of Polygons*).
3. Conics and Engineering Curves (*Ellipse, Parabola, Hyperbola*).
4. Conics and Engineering Curves (*Cycloid, Epicycloid, Hypocycloid, Trochoid, Involute*).
5. Projection of Points.
6. Projection of Lines.
7. Projection of Planes.
8. Projection of Solid (*Cube, Prism, Pyramids*).
9. Projection of Solid (*Cylinder, Cone and Sphere*).
10. Isometric projection of solids (*Prisms, Pyramids, Cylinders, Cone and Sphere*).
11. Development of Surfaces (*Truncated Cylinder, Square Prism, Pyramid, Truncated Cone*).
12. Introduction to CAD Tools (*Scale, Units, Draw, Modifying, Dimension, Sheet Layout, Plotting*).

Text Books:

1. T. E. French, C.J. Vierck and R. J. Foster, Engineering Drawing and GraphicsTechnology**,** TMH, 1987.
2. N. D. Bhatt and V.M. Panchal, Elementary Engineering Drawing, Charotar Publishing House, 1996.

Reference Books:

1. K.Venugopal, Engineering Drawing and Graphics, New Age, 2005.
2. Dhananjay A. Johle, Engineering Drawings, McGraw Hill Education Pvt. Ltd., 2008.

MA -201: ENGINEERING MATHEMATICS - II **3-1-0 = 4**

Subject Code: *MA - 201.*
Subject Name: *Engineering Mathematics - II.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

UNIT - I

*Calculus of several variables***:** Partial derivatives. Chain rule, Standard Jacobians for change of variables. Gradient and directional derivatives. Tangent and normal planes. Exact differentials. Euler's theorem on homogeneous functions. Repeated and multiple integrals, maxima and minima for several variables, method of Lagranges multipliers.

UNIT - II

*Vector Calculus***:** Vector valued function of one or more variables (up to 3), derivatives of such a function of one variable. Gradient of a scalar valued function. Geometrical properties of gradient. Divergence and Curl of vector valued functions. Line, surface, and volume integrals. Green's theorem, Gauss's divergence theorem and Stoke's theorem in Cartesian coordinates (statements only with applications).

UNIT – III

Numerical Methods: Bisection method, Newton-Rapson's and Secant methods for roots of nonlinear equations. Polynomial interpolation, divided differences.Numerical differentiaon and Numerical integration, trapezoidal and Simpson's rules..

UNIT-IV

*Ordinary Differential Equations (ODE)***:** Ordinary linear differential equations of nth order, solutions of homogeneous equations, Wronskian, Operator method (simple problems only with emphasis on second order homogeneous equations). Variation of Parameters for second order linear ODE with variable coefficients. Nonlinear equations and Clairaut's equations.

Text Books:

1. E. Kreyszig, "Advance Engineering Mathematics", 8th Ed, J. Willey & Co, 1999.
2. S. Pal and S. C. Bhunia, "Engineering Mathematics'' , Oxford University Press, 2015.
4. B.S. Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna Publication.

Reference Books:

1. Babu Ram, "Engineering Mathematics", Pearson.
2. Sastry, "Engineering Mathematics", PHI.
3. M. C. Potter, J. L Goldberg and E.F. Aboufadel, "Advance Engineering Mathematics" (Third Edition),Oxford University Press

PH -202 ENGINEERING PHYSICS - II **3-1-0 = 4**

Subject Code: *PH - 202.*
Subject Name: *Engineering Physics - II.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit-I: Laser and Fiber Optics

Fundamentals of LASER: Energy level in atoms, Spontaneous and stimulated emission, He-Ne laser, Applications of laser in drilling, welding, etc.
Introduction to optical fiber: Propagation of light in optical fibers, Numerical aperture, single and multimode fibers, Attenuation, Dispersion, Applications.

Unit-II: Wave mechanics

De Broglie Hypothesis. Wave-Particle Duality. Davisson-Germer Experiment. Group and Phase Velocities and Relation between them. Heisenberg uncertainty principle: Illustrations and applications, Wave function and its significance, Schrodinger wave equation, Particle in 1-D potential box.

Unit-III: Semiconductor Physics

Concept of Band theory of solids (qualitative description). Difference between metal, semi-conductor, and insulator. Direct and indirect band gap semiconductor, Intrinsic semiconductor, concept of holes – effective mass - carrier concentration and electrical conductivity. Intrinsic semiconductor at 0K and at room temperature, Fermi energy, Extrinsic semiconductor, conductivity, Hall effect.

Unit-IV: Nano Physics

Introduction to nanophysics. Properties of material from bulk to nano size. Fabrication of nanomaterials by physical methods and chemical methods. Applications of nano-materials in energy, health, space and environment etc.

Text Books:

1 Thomas A. Moore, Six Ideas that Shaped Physics:Particle Behave like Waves, 3/e McGraw Hill, 2003
2. Gerd Keiser, Optical Fibre Communications, 3/e, McGraw Hill, 2000
3. A K Bandopadhyay, Nano materials,. 2/e New Age International Pvt Ltd Publishers, 2007
4. Ben G. Streetman, Sanjay Banerjee, Solid State Electronic Devices, 6/e, **Pearson Prentice Hall,** 2006

Reference Books:

1. F W Sears, M W Zemansky and H D Young, University Physics, 2/e, Narosa Publishing House, 1982
2. H K Malik and A K Singh, Engineering Physics, Tata McGraw Hill, New Delhi, 2010.
3. David J Griffiths, Introduction to Quantum mechanics, 2/e Pearson, 2004.
4. S O Pillai, Solid State Physics,7/e, New age international, 2014

CH-203: ENGINEERING CHEMISTRY **3-1-0 = 4**

Subject Code: *CH-203.*
Subject Name: *Engineering Chemistry.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Chemical Thermodynamics: Second law of thermodynamics, entropy and its physical significance, entropy change of ideal gases, free energy, Maxwell's relations, Gibbs-Helmholtz equation, thermodynamic equilibrium, Van't Hoff equation, Clausius-clapeyron equation, Nernst heat theorem, third law of thermodynamics.

Unit-II

Organic Chemistry: Structures, functions and classification of biologically important molecules (Amino acids, peptides, proteins, Nucleic acids, Carbohydrates); Preparative methods of amino acids and Peptides; Peptides sequencing; 3D structure of proteins; Reactions of monosaccharides.

Polymers: Types of Polymerization; Classification and structures of polymers; commercial uses of some important polymers (e.g. Nylons, polyester, polyurethane, rubber, Teflon, polycarbonate, Bakelite, epoxy resin, silicones, etc.)

Unit- III

Electrochemistry: Electromechanical cells, EMF and application of its measurement, commercially important cells, corrosion (its electrochemistry and remedial measures)

Chemical Kinetics: reactions of different orders- general discussion, rate law with example of zero, first and second order reactions, problem based on zero, first and second order reactions, pseudo-uniorder reaction, activation energy and role of catalyst in reaction- collision theory and activation energy.

Unit IV

Water and its hazard in industry: Soft and Hard water and estimation of hardness of water, hazards of hard water in industry and treatment of industrial water (external and internal metods)

Fundamentals of Spectroscopy: Microwave, Infra-red and UV-VIS spectroscopic techniques.

Text books:

1. Prakash, Tuii, Basu and Madan, Advanced Inorganic Chemistry, Vol. I and II (Diamond Ed) S. Chand, Reprinted 2006.
2. Morrison and Boyd, Organic Chemistry, 6/e, Prentice Hall of India, reprinted, 2006.
3. Jain and Jain, Engineering Chemistry, Dhanpat Rai Publishing Co. 2008

Reference Books

1. Levine, Physical Chemistry, 5/e (7^{th} reprint), TataMcGraw Hil, 2006

EN – 204: BASIC ELECTRONIC DEVICES **3-1-0 = 4**

Subject Code: *EN-204.*
Subject Name: *Basic Electronic Devices.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Passive components: Resistors, capacitors and inductors: types and characteristics and their applications. Semiconductors: Energy bands in silicon, intrinsic and extrinsic, carriers transport in silicon: diffusion current, drift current, mobility and resistivity. Generation and recombination of carriers, Semiconductor materials.

UNIT II

PN junction diode: General idea of a PN junction diode, Reverse and forward biased characteristics, Transition capacitance and diffusion capacitance.PN Junction diode applications: Half wave rectifier, full wave center- tapped and bridge rectifier Clipping and clamping circuits.

UNIT III

Introduction to Special purpose diode characteristics and applications: Zener diode, Photo diode, Varactor diode, Light emitting diode, Schottky diode, Tunnel diode. BJT, FET (JFET and MOSFET) and UJT: Construction, symbols, principle of operation.

UNIT IV

Digital Electronics: Number systems and codes, Binary, Decimal, Hexadecimal. logic gates: AND, OR, XOR, NOT, NAND, NOR, XNOR. Boolean theorems, De-Morgan's theorems, Boolean algebra, minimization of Boolean functions.

Text Books:

1. Boylestead and Nashelsky, Electronic Devices and Circuits Theory, 9/E, PHI, 2006.
2. Bernard Grob and Mitchel Schultz, Basic Electronics, 9/E, TMH, 2003.
3. Morris Mano, Digital Design, 3/E, PHI, 2006.
4. J. Millman and C. C. Halkias, Integrated Electronics, 42nd Reprint, TMH, 2006.

Reference Books:

1. A. P. Malvino, Electronic Principles, 6/E, TMH, 1998.
2. R. P. Jain, Modern Digital Electronics, 3/E, TMH, 2003.
3. R. J. Tocci, Digital Systems, 6/E, PHI, 2001.

PH – 212: ENGINEERING PHYSICS LABORATORY **0-0-4 = 2**

Subject Code: *PH-212.*
Subject Name: *Engineering Physics Laboratory.*
No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments:

1. To determine the acceleration due to gravity by bar pendulum/Kater's pendulum.
2. To determine the Young's modulus of a wire by any method
3. To determine rigidity modulus of a wire by statical method/dynamical method.
4. To find the wavelength of monochromatic light by using Newton's ring method.
5. To determine the wavelength of sodium light by Michelson's interferometer.
6. To determine the specific rotation of sugar solution by Polarimeter.
7. To determine the magnetic moment of a bar magnet (M) and the earth's horizontal intensity at

1. a place by deflection and vibration magnetometers

8. To determine the wavelength of laser light using diffraction grating
9. To determine the resistance per unit length of a meter bridge wire by Carey- Foster method.
10. To determine the time constant of the RC circuit.
11. To obtain the hysteresis curves (B-H) for a ferromagnetic material (thin rod or wire) on a

2. CRO using solenoid and to determine the related magnetic constants.

12. To study the Hall Effect and determine the Hall Coefficient of a given material.
13. To determine the Planck's constant by a Photocell.
14. To determine the value of e/m of an electron by any method.
15. To determine the refractive index of a prism by using spectrometer.
16. To determine the velocity of ultrasonic waves in liquids.
17. To calibrate the given ammeter and voltmeter by potentiometer.
18. To determine energy band gap of a given semiconductor material.

Text Books:

1. Samir Kumar Ghosh, A Text book of Practical Physics, New Central Book Agency, Kolkata, 2006.
2. Gupta and Kumar, Practical Physics, Progati Prakashan, Meerut, U.P., 2005.
3. Harnam Singh, B.Sc. Practical Physics, S Chand and Company, 2004.
4. C. L. Arora, Advance B.Sc. Practical Physics, S. Chand, 2004.

CH- 213: ENGINEERING CHEMISTRY LABORATORY **0-0-4 = 2**

Subject Code: *CH-213.*
Subject Name: *Engineering Chemistry Laboratory.*
No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments:

1. Volumetric estimation of Mg2+ and Ca2+ ions by EDTA titration (Hardness of water).
2. Volumetric estimation of Fe2+ ions by permanganatometry.
3. Preparation of an inorganic complex like, potassium chlorochromate, sodium
1. cobaltinitrate, Fe(acac)3, etc.
4. Determination of concentration of the given liquid mixture by viscosity measurement.
5. Determination of partition-coefficient of iodine between carbon tetrachloride and water.
6. Determination of integral heats of dilution of the sulphuric acid solutions, and to determine
2. the strength of the given unknown acid solution.
7. Standardisation of a strong acid by conductometric titration with a strong base.
8. Experimental verification of Hasselbach-Henderson equation by pH measurement for a buffer mixture.
9. Determination of rate constant of the acid-catalysed hydrolysis of methyl acetate.
10. Verification of Beer-Lambert's law with potassium permanganate and the estimation of potassium present in the given solution.
11. Systematic qualitative analysis of organic compounds containing one functional group :
    a. Detection of element out of N, S, Cl, Br, I
    b. Detection of a functional group out of -COOH, -NO_2, -OH (alcoholic or phenolic),>CO carbonyl, -NH2 group.
12. Synthesis and characterization (by m.p. method) of para-nitro acetanilide.

Text Books:

1. Pandey, Bajpai and Giri, Practical Chemistry, 8/E (reprinted), S. Chand and Co. Ltd., 2006.
2. Gurtu andKapoor, Advanced Experimental Chemistry, Vol. I – III, 4/E (reprinted), S.Chand and Co. Ltd., 1989.

Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis, 5/E, ELBS, 1991.
2. Vogel's Textbook of Practical Organic Chemistry, 5/E, ELBS, 1996.

EN- 214: ELECTRONIC DEVICES LABORATORY **0-0-4 = 2**

Subject Code: *EN-214.*
Subject Name: *Electronic Devices Laboratory.*
No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments:

1. To plot the VI Characteristics curve of Silicon Diode.
2. To plot the VI Characteristics curve of Zener Diode.
3. To design and Analyse a Half wave Rectifier using Diode.
2. To design and Analyse of a centre-tap Full wave Rectifier using Diodes
3. To design and Analyse of a Bridge Rectifier Circuit.
4. To study and verify OR gate.
5. To study and verify AND gate.
6. To study and verify NOR gate.
7. To study and verify NAND gate.
8. To study and verify XOR gate.
9. To study and verify XNOR gate.

Text Books:

1. Boylestead and Nashelsky, Electronic Devices and Circuits Theory, 9/E, PHI, 2006.
2. R. P. Jain, Modern Digital Electronics, 3/E, TMH, 2003.

Reference Books:

1. A. P. Malvino, Electronic Principles, 6/E, TMH, 1998.
2. R. P. Jain, Modern Digital Electronics, 3/E, TMH, 2003.
3. R. J. Tocci, Digital Systems, 6/E, PHI, 2001.

EN – 215: ENGINEERING DRAWING **0-0-4 = 2**

Subject Code: *EN-215.*
Subject Name: *Engineering Drawing.*
No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Drawing Plates/Sheets:

3. Introduction of Drawing (*Sheet layout and Sketching, Lines, Lettering and Dimensioning).*
4. Geometrical Constructions (*Bisecting a lines, Perpendicular lines, divide a lines, Construction of Polygons*).
13. Conics and Engineering Curves (*Ellipse, Parabola, Hyperbola*).
14. Conics and Engineering Curves (*Cycloid, Epicycloid, Hypocycloid, Trochoid, Involute*).
15. Projection of Points.
16. Projection of Lines.
17. Projection of Planes.
18. Projection of Solid (*Cube, Prism, Pyramids*).
19. Projection of Solid (*Cylinder, Cone and Sphere*).
20. Isometric projection of solids (*Prisms, Pyramids, Cylinders, Cone and Sphere*).
21. Development of Surfaces (*Truncated Cylinder, Square Prism, Pyramid, Truncated Cone*).
22. Introduction to CAD Tools (*Scale, Units, Draw, Modifying, Dimension, Sheet Layout, Plotting*).

Text Books:

3. T. E. French, C.J. Vierck and R. J. Foster, Engineering Drawing and GraphicsTechnology**,** TMH, 1987.
4. N. D. Bhatt and V.M. Panchal, Elementary Engineering Drawing, Charotar Publishing House, 1996.

Reference Books:

1. K.Venugopal, Engineering Drawing and Graphics, New Age, 2005.
2. Dhananjay A. Johle, Engineering Drawings, McGraw Hill Education Pvt. Ltd., 2008.

EN- 301: BASICS OF RENEWABLE ENERGY TECHNOLOGY 3-1-0 = 4

Subject Code: *EN-301*
Subject Name: *Basics of Renewable Energy Technology.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

World energy use, reserves of energy resources-energy cycle of the earth-environmental aspects of energy utilisation-renewable energy resources and their importance. Conversion of solar energy to heat energy, solar energy to electrical energy-solar cells, Inorganic and organic solar cells.

Unit II

Biomass Energy, Biomass Conversion, Biogas Production, Bio-ethanol Production, Pyrolysis and Gasification, Direct Combustion and Applications. Bio photolysis, Basic theory and types of turbines, Geothermal Energy, Geothermal resource assessment, Resource based applications for heating and electricity generation, Basic concepts of Hydropower, Site selection, types of turbines, Small hydropower stations.

Unit III

Origin of tides, Power generation schemes, Wave Energy, Basic theory of wave power devices, Open and Closed OTEC cycles, Ocean Currents, Salinity Gradient Devices, Environmental Aspects, Potential impacts of harnessing the different renewable energy resources.

Unit IV

Introduction to petroleum resources, availability, production and distribution, Petroleum refining, Coal resource availability, types of coal. Depletion of petroleum and coal resources, Sustainability issues of conventional energy resources. Importance of non-renewable resources, Indian scenario. Impact of use of non-renewable recourses on environment.

Text Books:

1. S. Michaelides, E. Efstathios Alternative Energy Sources, Springer, 2012.
2. D. P. Kothari, K. C. Singhal and R. Ranjan, Renewable Energy Sources and Emerging Technologies, PHI, 2008.

Reference Books:

1. L. Rao, B. B. Parulekar, Energy Technology, 3/E, Khanna Publishers, 2009.
2. T. N. Veziroglu, Alternative Energy Sources, Vol 5 and 6, TMH, 2007.
3. A. Duffie, W. A. Beckmann, Solar Engineering of Thermal Processes, John Wiley, 2006.
4. F. Kreith, J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, 2000.

EN-302: ELECTRICAL DEVICES AND CIRCUITS **3-1-0 = 4**

Subject Code: *EN-302.*
Subject Name: *Electrical Devices and Circuits.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

DC Machines: Principle of DC Generator, Methods of excitation, Characteristics and Applications, Principle of DC Motor, Types, Speed – Torque Characteristic, Speed Control. Transformers: Working principle of Transformers, Equivalent Circuit, Transformer tests.

Unit II

Three Phase Induction Motor: Construction, Production of rotating field, Slip, Torque and Slip. Single Phase Induction Motor: Double field revolving theory, Shaded Pole single phase induction motor. Stepper Motors.

Unit III

Electrical analogy of simple mechanical systems; concept of transfer function and its determination for simple systems. Open loop and closed loop controls, servo mechanisms, concept of various types of system. Unit step, unit ramp, Unit Impulse and periodic signals with their mathematical representation and characteristics.

Unit IV

Time response of a standard second order system and response specifications, steady state errors and error constants. Concept and types of stability, Routh-Hurwitz Criteria and its application for determination of stability, limitations; Polar plot, Nyquist stability. Correlation between time and frequency responses of a second order system; Bode plot, gain margin and phase margin and their determination from Bode and Polar plots

Text Books:

1. W.H. Hayt, J.E. Kemmerly and S.M. Durbin, Engineering Circuit Analysis, 6/E, TMH, 2006.
2. M.Gopal, Control Systems: Principles and Design, TMH, 2012.
3. B.L. Thereja and A.K. Thereja, Electrical Technology, Vol-II, S. Chand, Reprint 2006.

Reference Books:

1. Van Valkenburg, Network Analysis, 3/E, PHI, 2005.
2. D. Roy Choudhury, Networks and Systems, New Age Publishers, 1998.
3. F. Golnaraghi, B.C. Kuo, Automatic Control systems. Wiley India Ltd, 2007.

EN-303: FLUID MECHANICS **3-1-0 = 4**

Subject Code: *EN-303.*
Subject Name: *Fluid Mechanics.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Newtonian and Non-Newtonian Fluids, Viscosity, Incompressible and compressible fluids, compressibility. Forces on plane surfaces, forces on curved surfaces, buoyant forces, and stability of floating bodies, metacentre and metacentre height.

Unit II

Steady and unsteady flow, uniform and non-uniform flow. Laminar and turbulent flow, streamline, path line and streak line, continuity equation, irrotational and rotational flow, velocity potential and stream function, vortex flow, free and forced vortex.

Unit III

Euler's equation of motion and its integration to yield Bernoulli's equation, its practical applications – Pitot tube, Venturi meter, orifice plate, steady flow momentum equation, force exerted on a pipe bend. Introduction to boundary layer formation, Novier-stokes equation.

Unit IV

Boundary layer thickness, momentum thickness, energy thickness, Boundary layer equations, Kinematics and Dynamic similarity, Dimensionless numbers-Reynolds, Froude, Euler, Mach, Weber Number and their significance.

Text Books:

1. S. K. Som, G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, TMH Publication, 2011.
2. D. S. Kumar, Fluid Mechanics and Hydraulic Machines, S.K. Kataria and Sons, 2011.
3. R. K. Bansal, A Text Book of Fluid Mechanics and Hydraulic Machines, Laxmi Publication, 2010.

Reference Books:

1. B. R. Munson, A. P. Rothmayer, T. H. Okiishi and W. W. Huebsch, Fundamentals of Fluid Mechanics, 7/E, Wiley, 2012.
2. G. E. Totten, V. J. De-Negri, Handbook of Hydraulic Fluid Technology, 2/E, CRC Press, 2011.
3. I. H. Shames, Mechanics of Fluids, TMH, 2005.

EN-304: ENGINEERING THERMODYNAMICS **3-1-0 = 4**

Subject Code: *EN-304.*
Subject Name: *Engineering Thermodynamics.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Concepts of Thermodynamics, Macroscopic and Microscopic, System and its Classification, Thermodynamic State, Properties, Process and Cycles, Thermodynamic Equilibrium, First Law Of Thermodynamics First Law applied to Non-Flow and Flow Processes, Concepts of internal Energy, Enthalpy, Specific Heats, PMMI, Energy Equations for Flow Systems, Applications. Statements of the Second Law of Thermodynamics and their equivalence, Carnot cycle, Reversibility and Irreversibility, Causes of Irreversibility, Reversible Cycles, Carnot Theorem, Absolute Thermodynamic Temperature Scale.

Unit II

Entropy, Clausius Theorem and Inequality, Entropy Principle, Entropy and Disorder, Evaluation of Entropy change during various processes, T-S and H-S diagrams, Concept of Third Law of Thermodynamics. Availability of Non-Flow as well as Flow Processes, Gibbs' Function, Helmholtz Function, Maxwell Relation, T-ds Equations, Clapeyron Equation, Concept of energy.

Unit III

Reciprocating Air Compressors Single stage and multistage air compressors, work done per cycle, compressor capacity and power computation, volumetric efficiency and isothermal efficiency, effect of clearance ratio on volumetric efficiency, intercooler and after cooler.

Unit IV

Properties of Substances Gases- Equation of state of an Ideal Gas, Entropy change of Ideal Gases. Equation of state of Real Gases, Principle of corresponding state, Compressibility Factor Steam-Definition of Sensible Heat, Latent Heat, Saturation Temperature, Quality, Evaluation of Properties from Steam Table and Mollier Diagram.

Text Books:

1. M. J. Moran, H. N. Shapiro, D. D. Boettner and M. B. Bailey, Principles of Engineering Thermodynamics, John Wiley and Sons Ltd, 2011.
2. M. W. Ziemansky, R. H Dittman, Heat and Thermodynamics, TMH, 2011.
3. P .K. Nag, Engineering Thermodynamics, TMH, 2008.

Reference Books:

1. M. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley, 2010.
2. M. L. Mathur and F. S. Mehta, Thermal Engineering, Jain Brothers, 2009.
3. P. Rogers and R. Mayhew, Engineering Thermodynamics, Pearson Higher Education, 1996.

EN-315 ENERGY LABORATORY -I **0-0-4 = 2**

Subject Code: *EN-315.*
Subject Name: *Energy Laboratory -I.*
No. of Hours Per Week: *Practicals-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments:

1. To verify the Bernoulli's Theorem by Bernoulli's theorem apparatus.
2. To determine the coefficient of discharge of an orifice of a given shape.
3. To determine the coefficient of discharge of liquid using Venturimeter
4. To demonstrate the functioning of Two stroke petrol Engine with working model.
5. To demonstrate the functioning of Four stroke petrol Engine with model.
6. To demonstrate the functioning of Two stroke Diesel Engine with model.
7. To demonstrate the functioning of Four stroke Diesel Engine with model.
8. To determine the thermal conductivity of a metallic rod.
9. To determine the thermal conductivity of a solid by the guarded hot plate method
10. To determine the rate of Heat Transfer through Composite Wall
11. To determine the rate of Heat Transfer through Composite Cylinder
12. To determine the meta-centric height of a floating body

Text Books:

1. S. K. Som, G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, TMH Publication, 2011.
2. F. P. Incropera, D.P. DeWitt, Fundamentals of Heat and Mass Transfer, John Willy and Sons, 2011.
3. F. P. Incropera, D.P. DeWitt, Fundamentals of Heat and Mass Transfer, John Willy and Sons, 2011.

Reference Books:

1. B. R. Munson, A. P. Rothmayer, T. H. Okiishi and W. W. Huebsch, Fundamentals of Fluid Mechanics, 7/E, Wiley, 2012.
2. G. E. Totten, V. J. De-Negri, Handbook of Hydraulic Fluid Technology, 2/E, CRC Press, 2011.
3. I. H. Shames, Mechanics of Fluids, TMH, 2005.
4. S. Arora, S. Domkundwar, and A. Domkundwar, A Course in Heat and Mass Transfer, DhanpatRai and Co., 2008
5. M. Thirumaleshwar, Fundamentals of Heat and Mass Transfer, Pearson Education, 2006.
6. S. Arora, S. Domkundwar, and A. Domkundwar, A Course in Heat and Mass Transfer, DhanpatRai and Co., 2008.

EN-401: HEAT AND MASS TRANSFER **3-1-0 = 4**

Subject Code: *EN-401.*
Subject Name: *Heat and Mass Transfer.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Concepts of the mechanisms of heat flows, Conduction, convection and radiation, Effect of temperature on thermal conductivity of materials, One-dimensional general differential heat conduction equation in the rectangular, cylindrical and spherical coordinate systems, Initial and boundary conditions, Electrical Analogy of heat, Critical thickness of insulation. Heat transfer from extended surfaces, Heat transfer through fins of uniform cross-sectional area.

Unit II

Hydrodynamic boundary layer, Thermal boundary layer, Approximate integral boundary layer analysis, Analogy between momentum and heat transfer in turbulent flow over a flat surface, Relation between fluid friction and heat transfer.
Natural Convection, Physical mechanism of natural convection, Buoyant force; Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere, Combined free and forced convection.

Unit III

Basic radiation concepts, Radiation properties of surfaces, Black body radiation, Planck's law, Wein's displacement law, Stefan Boltzmann law, Kirchoff's law, Gray Body, Shape factor, Radiation exchange between diffuse non-black bodies in an enclosure, Radiation combined with conduction and convection, Absorption and emission in gaseous medium, Radiation shields, Solar radiation, Greenhouse effect.

Unit IV

Types of heat exchangers, Fouling factors, Overall heat transfer coefficient, Logarithmic mean temperature difference (LMTD) method, Effectiveness-NTU method, Compact Heat Exchangers. Condensation and Boiling, Introduction to condensation phenomena, Heat transfer relations for laminar film condensation on vertical surfaces and on outside and inside of a horizontal tube, Effect of non-condensable gases, Dropwise condensation, Heat pipes, Boiling modes, pool boiling. Introduction, Fick's law of diffusion, Steady state equimolar counter diffusion, Steady state diffusion though a stagnant gas film.

Text Books:

1. J.P. Holman, Heat Transfer, TMH,2010.
2. F. P. Incropera, D.P. DeWitt, Fundamentals of Heat and Mass Transfer, John Willy and Sons, 2011.

Reference Books:

1. M. Thirumaleshwar, Fundamentals of Heat and Mass Transfer, Pearson Education, 2006.
2. S. Arora, S. Domkundwar, and A. Domkundwar, A Course in Heat and Mass Transfer, Dhanpat Rai and Co., 2008.

EN-402: NUCLEAR ENERGY **3-1-0 = 4**

Subject Code: *EN-402.*
Subject Name: *Nuclear Energy.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I
Mechanism of Nuclear Fission and Nuclear Fusion, Nuclides, Radioactivity, Decay Chains, Neutron Reactions, the Fission Process, Reactor types, Fast Breeding.

Unit II
Design and Construction of Nuclear reactors, Heat Transfer Techniques in Nuclear Reactors, Reactor shielding. Nuclear Fuel Cycles, Characteristics of Nuclear Fuels, Uranium.

Unit III
Production and Purification of Uranium, Conversion to UF_4 and UF_6. Other Fuels like Zirconium, Thorium, Beryllium, Nuclear Fuel Cycles for other fuels, Spent Fuel Characteristics, Thorium based green nuclear energy.

Unit IV
Role of Solvent Extraction in Reprocessing, Solvent Extraction Equipment, Processes to be Considered, 'Fuel Element' Dissolution, Precipitation Process-Ion Exchange, Redox, Purex, TTA-Chelation, U-235, Hexone-TBP and Thorax Processes, Electro-Refining, Isotopes, Principles of Isotope Separation.

Text Books:
1. N. Tsoulfanidis, Nuclear Energy, Springer 2013.
2. M. Greenberg, Nuclear Waste management, Nuclear power, and Energy Choices, Springer 2013.

Reference Books:
1. M. Manu, Nuclear Power, Economic development discourse and the environment: The case of India, Taylor and Francis Group, 2013.
2. T. Jevremovic, Nuclear principles in engineering, 2/E, Springer 2009.
3. D. Bodansky, Nuclear Energy: Principles, practices, and prospects, 2/E, Springer; 1996.

EN-403: SOLAR THERMAL TECHNOLOGY **3-1-0 = 4**

Subject Code: *EN-403.*
Subject Name: *Solar Thermal Technology.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Earth and Sun Relation, Solar angles, day length, angle of incidence on tilted surface, Sun-path diagrams, Shadow determination, Extra-terrestrial characteristics, Effect of earth atmosphere on terrestrial solar radiation.

Unit II

Flat-plate Collectors, Glazing Materials, collector Plates. Evacuated tubular collectors, Types of Air flat-plate Collectors. Testing of collector, Orientable test ring, series connected test ring, interminant output method. ASHRAE method. Effective energy losses, top, bottom, side and overall loss coefficient.

Unit III

Concentrating Collector, Characteristic parameters, Classification, tracking and non-tracking concentrators, Central receiver systems, parabolic trough and compound parabolic systems, Solar furnaces.

Unit IV

Solar Thermal Energy Systems, Solar still, Solar cooker, Solar pond, Solar passive heating and cooling systems, Trombe wall, Fundamentals of Greenhouse technology, design, modelling and applications**,** Development of computer package for solar heating and cooling applications.

Text Book

1. G.N. Tiwari, Solar Energy, Fundamentals, design, modelling and applications, Narosa, 2012.
2. A. Duffie and W. A. Beckmann, Solar Engineering of Thermal Processes, John Wiley, 2006.

Reference Books:

1. K. Lovegrove, W. Stein, Concentrating Solar Power Technology, Woodhead Publishing, 2012.
2. T.C.Kandpal, H. P. Garg, Financial Evaluation of Renewable Energy Technology, Macmilan India Ltd. New Delhi, 2003.
3. F.Kreith and J.F.Kreider, Principles of Solar Engineering, Taylor and Francis,2000.
4. Z. Jagoo, Tracking Solar Concentrators, Springer, 2013.
5. Z. Sen, Solar Energy Fundamentals and Modelling Techniques, Springer, 2008.

EN-404: BIOMASS AND BIO-FUEL TECHNOLOGY **3-1-0 = 4**

Subject Code: *EN-404.*
Subject Name: *Biomass and Bio-fuel Technology.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Selection of biomass as feedstock, Introduction to photosynthesis, characteristics of C_3 and C_4 plants as biomass fuel, physicochemical characteristics of biomass as fuel, Biochemical, chemical and thermo-chemical biomass conversion routes, Biochemical conversion by Aerobic and Anaerobic digestion of biomass.

Unit II

Types of digesters, design of biogas plants, installation, operation and maintenance of biogas plants, biogas plants manure-utilization and manure values, Biogas storage, biogas for motive power generation, Alcohol production from biomass, Types of Materials of alcohol production-process description, distillation.

Unit III

Chemical conversion processes, hydrolysis and hydrogenation, Biofuels-different processes of production, Economics on utilization, Mechanism of trans-esterification, fuel characteristics of biodiesel, technical aspects of biodiesel engine application, Bio-diesel storage, Induction time, Oxidation stability, Principle and working of Rancimat apparatus for oxidation stability.

Unit IV

Concept of Waste land, selection of plants for energy plantation, utilization through energy plantation in waste land, Biomass based power generation using biomass gasifiers and biogas plants, Classification of Bio-fuels from Plant and animal wastes, advantages and disadvantages of bio-fuel produced from animal wastes over plant feedstock.

Text Books:

1. Ruth Owen, Energy from Plants and Trash: Biofuels and Biomass Power, Power Kids Press, 2013.
2. R. C. Brown, Thermochemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, John Wiley & Sons, 2011.
3. P. Basu, Biomass gasification and Pyrolysis: Practical design and theory, Academic Press, 2010.

Reference Books:

1. H. S. Mukunda, Understanding Clean Energy and Fuels From Biomass, Wiley India Pvt Ltd, 2011.
2. Rosillo-Calle Frank, Francisco Rosillo, The Biomass Assessment Handbook: Bioenergy for a Sustainable Environment, Earthscan, 2007.
3. G. D. Rai, Non-conventional energy sources, Khanna Publishers, 2007.
4. S. Bent, Renewable Energy, 2/E, Academic press, 2000.

EN-415 ENERGY LABORATORY -II **0-0-4 = 2**

Subject Code: *EN-415.*
Subject Name: *Energy Laboratory -II.*
No. of Hours Per Week: *Practicals-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments:

1. To study the working of a Micrometer.
2. To study the working of a Tachometer
3. To study the working principle and range of a Strain gauge.
4. To study the working principle and range of a Rotameter
5. To compare the energy consumption of electronic ballast and conventional ballast.
6. To determine the illumination level of a room.
7. To determine the illumination level of a corridor without windows.
8. To determine the percentage of electrical loading of single phase motor using power analyser.
9. To determine the percentage of electrical loading of three phase motor using power analyser.
10. To analyse the flue gas using flue gas analyser and to determine the concentration of NOx and SOx.
11. To determine the CO and CO_2 concentration in the flue gas.
12. To evaluate the heat loss of a given furnace at different given conditions.

Text Book

1. Dall'O' Giuliano, Green Energy Audit of Buildings, Springer, 2013.
2. Y. P. Abbi, S. Jain, Energy Audit and Environment Management, The Energy Research Institute India, 2006.
3. I. C. Flavio, The Energy Audit of Electric Motor Driven Systems, Springer, 2003.

Reference Books:

1. A. T. Thumann, W. J. Younger. Hand Book of Energy Audits, CRC Press 2003
2. Bureau of Energy Efficiency (BEE). Study material for Energy Managers and Auditors Examination: Volume I-IV. 2003.
3. I. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management and Case study, Hemisphere, Washington, 1990.

EN-501: PHOTOVOLTAIC CONVERSION TECHNOLOGY **3-1-0 = 4**

Subject Code: *EN-501.*
Subject Name: *Photovoltaic Conversion Technology.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Solar Cell Physics, PN junction, homo and hetero-junctions, Metal-semiconductor interface, Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, Efficiency measurements, High efficiency cells, Tandem structure, Junctions in Organic Solar Cells, Working and Efficiency limits.

Unit II

Solar Cell Fabrication Technology, Preparation of metallurgical junction, electronic and solar grade Silicon, Production of single crystal Silicon by Czokralski (CZ) and Float Zone (FZ) methods, Procedure of masking, photolithography and etching, Design of a complete silicon, GaAs, InP solar cell; High efficiency III-V, II-VI multi-junction solar cell, a-Si-H based solar cells, Quantum well solar cell.

Unit III

Organic photovoltaic materials, principle and working, exciton generation, dissociation and transport, Basic principle of DSSC, Excitonic solar cell materials, Hole and electron transport, charge dissociation and capture. Perovskites: synthesis, properties and application in Solar Cell.

Unit IV

SPV Applications, Centralized and decentralized SPV systems, Stand alone, hybrid and grid connected system, System installation, operation and maintenance, Solar Photovoltaic System Design, Solar cell array system analysis and performance prediction, Shadow analysis, Reliability, Solar cell array design concepts.

Text Books:

1. C.H. Wallace, Organic Solar Cells, Springer 2013.
2. F. C. Krebs, Stability and Degradation of Polymeric Solar Cells, Wiley, 2012.
3. C. S. Solanki, Solar Photovoltaics: Fundamental Technologies and Applications, PHI Learning Pvt Ltd. India, 2009.

Reference Books:

1. K. Boer, Handbook of physics of Thin-Film solar cells, Springer 2013.
2. K. Kalyanasundaram, Dye Sensitized Solar cell, CRC Press, 2010.
3. Solar Energy International, Photovoltaics: Design and Installation Manual, New Society Publishers, 2004.
4. D. P. Larry, Solar Cells and their Applications, John Wiley and Sons, New York, 1995.

EN-502: ENERGY ACCOUNTING AND MANAGEMENT **3-1-0 = 4**

Subject Code: *EN-502.*
Subject Name: *Energy Accounting and Management.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Basic concepts of Energy Conservation, Energy conservation in household, transportation, agricultural, service and industrial sectors, Lighting, HVAC systems Energy Audit, Need and types of energy audit. Energy management (audit) approach, Understanding energy costs, bench marking, energy performance, maximizing system efficiencies, optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.

Unit II

Material and Energy balance, Facility as an energy system, Methods for preparing process flow, material and energy balance diagrams, Energy Action Planning, Key elements, Force field analysis, Energy policy purpose, perspective, contents, formulation, ratification, Organizing the management, location of energy management, Energy Conservation Act 2001 and amendments.

Unit III

Duties and responsibilities of energy managers and auditors as per Energy Conservation Act 2001, Defining monitoring and targeting, Elements of monitoring and targeting, Data and information analysis and techniques, Energy consumption, production, cumulative sum of differences (CUSUM).

Unit IV

Functions of Energy Service Companies, Energy management information systems, SCADA system. National Mission for Energy Efficiency Enhancement Programme, Electrical Energy Supply side Management, Methods to minimize supply-demand gap, renovation and modernization of power plants, reactive power management, HVDC, and FACTS, Demand side conservation in motors, pumps and fan systems, energy efficient motors.

Text Book

1. Dall'O' Giuliano, Green Energy Audit of Buildings, Springer, 2013.
2. Y. P.Abbi, S. Jain, Energy Audit and Environment Management, The Energy Research Institute India, 2006.
3. I. C.Flavio, The Energy Audit of Electric Motor Driven Systems, Springer, 2003.

Reference Books:

1. A. T.Thumann, W. J. Younger. Hand Book of Energy Audits, CRC Press 2003
2. Bureau of Energy Efficiency (BEE). Study material for Energy Managers and Auditors Examination: Volume I-IV. 2003.
3. I. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management and Case study, Hemisphere, Washington, 1990.

EN-503: FUEL, COMBUSTION AND IC ENGINE **3-1-0 = 4**

Subject Code: *EN-503.*
Subject Name: *Fuel, Combustion and IC Engine.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Characteristics and Properties of Fuels, Octane number, flame point, calorific value, adiabatic flame temperature, viscosity of liquid fuels, specific heat, specific gravity, pour point, density, sulphur content, ash content, carbon residue, water content. Advantages and disadvantages of solid, liquid and gaseous fuels.

Unit II

Combustion Thermodynamics, Thermo-chemistry, Heat of Reaction, Calorific Value, Combustion Kinetics. Diffusion Flame, Mixed Flame, Flame Velocity, Formation of Pollutants – CO, Soot, NO_X and SO_X.

Unit III

Introduction to I.C Engines, Engine classification, Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, Actual cycle analysis, Two and four stroke engines, SI and CI engines, Valve timing diagram.

Unit IV

Combustion in CI engines, Ignition delay, Knock and it's control, Fuel injection in CI engines, Types of injection systems, Fuel pumps, Fuel injectors. Gas turbine classification, Brayton cycle, Principles of gas turbine, Gas turbine cycles with inter-cooling, Stage efficiency, Deviation of actual cycles from ideal cycles.

Text Books :

1. W. R. May, The Chemistry of Hydrocarbon Fuel Combustion, SFA International, 2013.
2. W. H. Booth, Liquid Fuel and Its Combustion, Westminster Constable Publication, 2012.
3. V. Ganesan, Internal combustion Engines, 4/E, TMH, 2012.

Reference Books:

1. D. K. Clark, Fuel: Its Combustion and Economy, Nabu Press, 2010.
2. M. Taniguchi, K. Yamamoto, Oxy-Fuel Combustion: The $NO_x$and Coal Ignition Reactions, Nova Science Publishers, 2010.
3. S.N. Saha, Fuel Combustion Energy Technology, Dhanpat Rai and Sons, 2003.
4. B. K. Sharma, Fuels and Petroleum Processing, Goel publishing, Meerut, 2000.
5. R. P. Sharma, M. L. Mathur, Internal Combustion Engines, Dhanpat Rai Publications,2010

EN-504: NANOTECHNOLOGY AND ENERGY SYSTEMS **3-1-0 = 4**

Subject Code: *EN-504.*
Subject Name: *Nanotechnology and Energy Systems.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Concept of Nanomaterials, Quantum dots, 1, 2 and 3 dimensional nanostructures, Top down and bottom up approach for synthesis of nanomaterials., Classification of Carbon nanomaterials, Synthesis of CNMs using CVD, PVD and Arc Discharge techniques. Physical and Chemical properties of CNMs. CNMs for Energy Application.

Unit II

Characterization techniques for nanoparticles by Raman spectroscopy and electron microscopy, Brag's law and X-ray diffraction technique, Stability of emulsions and Zeeta potential, Photoluminiscence spectroscopy, Visco-elastic materials and Rheometry.

Unit III

Synthesis of Titania nanoparticles, Photocatalytic applications, d-group metal oxide based nanocomposite for photocatalytic reactors, Tuning the workfunction of d-group metal oxide, nanoparticles as visible active photocatalyst, Exciton dissociation, charge transport, nanoparticles in DSSC and organic solar cells

Unit IV

Ionic nano-fluids, introduction, synthesis and properties, Bio-diesel production using ionic-fluid and nanocatalyst, Advantages and disadvantages of using ionic nano-fluid and nanocatalyst for bio-diesel production, Fuel characteristics of bio-diesel prepared by ionic nano-fluids, Emission characteristics, Feasibility study and environmental impact of Nanomaterisls.

Text Books:

1. B.S. Murty, P. Shankar, B. Raj, B.B.Rath, J. Murday, Textbook of Nanoscience and Nanotechnology, Springer, 2013.
2. Q. Zhang, Carbon nanotubes and their applications, CRC Press, 2012.
3. K. K. Akurati, Synthesis of TiO_2 based nanoparticles for photocatalytic applications, Cuvillier Verlag, 2008.

Reference Books:

1. E. Gusev, E. Garfunkel, A. Dideikin, Advanced Materials and Technologies for Micro/Nano - Devices, Sensors and Actuators, Springer, 2010.
2. W.D. CallisterJr, D. G Rethwisch, Materials Science and Engineering: An Introduction, John Wiley, and Sons, 2009.
3. M. S. Dresselhaus, G. Dresselhaus and P. Avouris, Carbon nanotubes: synthesis, structure, properties and applications, Springer, 2001.

EN-515 ENERGY LABORATORY -III **0-0-4 = 2**

Subject Code: *EN-515.*
Subject Name: *Energy Laboratory -III.*
No. of Hours Per Week: *Practicals-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments:

1. To determine the diffuse solar radiation at solar noon at a given site.
2. To determine the beam solar radiation at solar noon at a given site.
3. To determine the total solar radiation at solar noon at a given site
4. To determine the maximum voltage and current output of series and parallel combination of four solar cells under a solar simulator
5. To determine the maximum power point of series and parallel combination of four solar cells
6. To study the I-V characteristics of a solar cell or panel under solar simulator.
7. To determine the FF of a given solar cell using solar simulator.
8. To determine the Quantum efficiency of a given solar cell using IPCE system
9. To study of the heat loss factor of a solar flat plate collector.
10. To study the flat plate solar water heater
11. To determine the figure of merit for a box type solar cooker.
12. To evaluate the zeta potential of the given nanoparticles is three different solvents provided
13. To estimate the particle size distribution and molecular mass of the given sample
14. To study the absorption spectra of the given sample in Visible, UV and NIR range.

Text Book

1. C. Richter, D. Lincot and C. A. Gueymard, Solar Energy, Springer 2013.
2. S.P.Sukhatme, Solar Energy:Principles of Thermal Collection and Storage, TMH, 2008.
3. C. S. Sollonki, Solar Photovoltaics: Fundamental Technologies and Applications, PHI Learning Pvt Ltd. India, 2009.

Reference Books:

1. G.N. Tiwari, Solar Energy, Fundamentals design, modelling and Applications, Narosa publication, 2010.
2. C. S. Solanki, Solar Photovoltaics: Fundamental Technologies and Applications, PHI, 2009.
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, USA, 2000.
4. K. Boer, Handbook of physics of Thin-Film solar cells, Springer 2013.

EN-601: FUEL CELL AND HYDROGEN ENERGY **3-1-0 = 4**

Subject Code: *EN-601.*
Subject Name: *Fuel cell and Hydrogen Energy.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Hydrogen as an alternate fuel, Physical and chemical properties of Hydrogen as a fuel, Advantages and limitations of Hydrogen over conventional fuels, Hydrogen Economy, Suitability of Hydrogen as a fuel and Fuel Cell as energy conversion device, Hydrogen Transport, Technical constraints of transport of Hydrogen by Road, Railway, Pipeline, and by Ship. Safety measures for Hydrogen production, transport and storage.

Unit II

Hydrogen Production from fossil fuels, electrolysis, thermal decomposition, photochemical, photo-catalytic, hybrid, Sea as a source of Deuterium, production of hydrogen from sea water, Hydrogen Storage in Metal hydrides, Metallic alloy hydrides, Basic thermodynamics of Fuel Cell, Reaction kinetics, Charge and mass-transport.

Unit III

Fuel Cell modelling for charge and mass transport, In-situ and Ex-situ Fuel Cell characterization, System and components of a Fuel Cell, Types of Fuel Cells based on working temperature, electrolyte and fuel, Fuel Cell power stations, Power management, Thermal management, Pinch analysis.

Unit IV

Working principle of low temperature Fuel Cells, Alkaline Fuel Cell and Polymer Electrolyte Fuel Cell, Working principle of high temperature Fuel Cells- Solid Oxide Fuel Cell and Molten Carbonate Fuel Cell, Fuel Cell systems and sub-systems, system and subsystem integration.

Text Books:

1. Kreuer, Klaus-Dieter, Fuel Cells, Springer, 2013.
2. M. Shao, Electrocatalysis in fuel cells, Springer, 2013.

Reference Books:

1. R. O'Hayre, S. Cha, W. Colella and F. B. Prinz, Fuel Cell Fundamentals, John Wiley and Sons, New York, 2006.
2. N. Sammes, Fuel Cell: Technology: Reaching Towards Commercialization, Springer, 2006.
3. Sorensen B. Hydrogen and Fuel Cells, Academic Press, 2005.

EN-602: ENERGY ECONOMICS AND PLANNING **3-1-0 = 4**

Subject Code: *EN-602.*
Subject Name: *Energy Economics and Planning.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Introduction to Energy economics, Basic concepts, National accounting framework, Criteria for sustainable development, Economic theory of demand, production and cost market structure, Calculation of unit cost of power generation from different sources with examples, Eco-ground rules for investment in energy sector.

Unit II

Payback period, NPV, IRR, and benefit-cost analysis with examples, Socio-economic evaluation of energy conservation programme, Application of econometrics, input and output optimization and simulation methods to energy planning and forecasting problems, Dynamic models of the economy and simple theory of business fluctuation.

Unit III

Uncertainties and social cost-benefit analysis of renewable energy systems, Financing mechanism of different renewable energy systems, Case studies, Renewable energy projects for reductions in CO_2 emissions, Conflict between energy consumption and environmental pollution, Economic approach to environmental protection and management, Externalities, economics of pollution control, emission taxes, subsidies.

Unit IV

Evaluation of National and Regional energy policies, oil import, energy conservation, rural energy economics, Environmental accounting, Cost and benefit analysis, Economic and financial analysis of environmental impacts, valuation methods, International Negotiation on Climate Change, Energy efficiency, Cost-benefit risk analysis, Project planning and implementation.

Text Books:

1. R. Lea, Business Models for Renewable Energy for Built Environment, Taylor and Francis, 2013.
2. S. C. Bhattacharya, Energy Economics: Concepts, Issues, Markets and Governance, Springer, 2011.

Reference Books:

1. T. C. Kandpal, H. P. Garg, Financial Evaluation of Renewable Energy Technology, Macmilan India Ltd., 2003.
2. E. B. Ferdinand, Energy Economics: A Modern Introduction, 1/E, Kluwer, London, 2000.
3. R. L. Pirog, S. C. Stamos, Energy Economics: Theory and Policy, Prentice- Hall, New Jersey, 1997.

HU-60311: INDUSTRIAL MANAGEMENT ANF ENTREPRENEURSHIP 3-1-0 = 4

Subject Code: *HU-60311.*
Subject Name: *Industrial Management and Entrepreneurship.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit – I

Entrepreneurship Theory -The Entrepreneurial Mind set, The Entrepreneurial Process Creativity and Innovation, Entrepreneurship Practice, Essentials of Business Ownership, New Venture Planning and Creation, Managing and Growing the Venture

Unit – II

Concept of demand and supply, elasticity of demand, types of market structure, firm and industry, business cycle, input and out analysis, plant location decision, Types of cost., Production process, types of production, plant layout, production planning and control, Inventory control techniques.

Unit – III

Management principles and functions, managerial skills, decision making process, types of organization structures, Maslow's hierarchy of needs, types of communication, leadership styles.

Unit – IV

Marketing concept, factors affecting consumer behaviour, types of market segments, product life cycle, pricing methods, distribution channels, advertising and sales promotion, value engineering.

Text Books:

1. R.R. Barthwal, Industrial Economics: An Introductory Text Book, New Age, 2000.
3. Ahuja, H, L., Managerial Economics, S. Chand and Company Ltd., New Delhi, 2007.
4. Murugan , M and Sakthivel, Management Principles and Practices , New Age International Publishers, New Delhi, 2008.
5. Aswathapa, K, Human Resource and Personnel Management, TMH, New Delhi, 2005.

Reference Books

1. Kotler, Keller, Koshy, Jha, Marketing Management-A South Asian Perspective, Pearson Ltd., 2009.
2. Entrepreneurial Development by C. B. Gupta and N. P. Srinivasan, Publisher Sultan Chand & Sons, 1992.

HU-60312: Introduction to IPR **3-1-0 = 4**

Subject Code: *HU-60312.*
Subject Name: *Introduction to IPR.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit – I

Engineering as a profession, historical and social context, Ethics in Engineering, Codes of Engineering Ethics, history and purpose, consequentialism and utilitarianism, Deontological approaches, duties, rights and respect for a person, responsibility, virtue Ethics, honesty, moral autonomy, obligations of Engineering profession and moral propriety.

Unit – II

Engineer's moral responsibility for safety and human right, risk assessment and communication, product liability, development ethics, engineers and employer relationship, whistle blowing and its moral justifications. Computer Ethics: Social impact of computers, privacy, cybercrime, ethical use of software.

Unit – III

IPR I: Intellectual property, definition, types, rights and functions, patents, trademark, software design, industrial designs, semi-conductor and integrated circuits layout design, grant of patent in India, authority and procedure, patent forms, surrender and revocation of patents and compulsory licensing, acquisition of inventions by the Government.

Unit – IV

IPR II: Contents of draft application for patents, Drafting patent specification and claims, WTO and drafting patent specification and claims, IPR infringement and piracy under Indian Laws.

Text Books:

1. Vinod V. Sople, Managing Intellectual Property: The Strategic Imperative, PHI, 2006.
2. Charles and Harri Michael S Pritchard and Michael J Robins, Engineering Ethics: Concepts and cases, Wordsworth/ Thompson Leaaring, Belmont Calif, 2000.
3. Dr. B. L. Wadehra, Law Relating to Intellectual Property, Universal Law Publishing, 2009

Reference Books:

1. Huff and Finholt, Social Issues in Computing: Putting Computing in Place, McGraw Hill,1994.
2. Govindarajan, Natarajan and Senthil Kumar, Engineering Ethics, PHI, 2004.
4. Jones and Bartlett, Cyber Ethics: Morality and Law in Cyber Space,4/e, Jones and Bartlett India Pvt. Ltd 2011.

HU-60313: OPERATION RESEARCH TECHNIQUES **3-1-0 = 4**

Subject Code: *HU-60313.*
Subject Name: *Operation Research Techniques.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, big-M method, two-phase method, degeneracy and unbound solutions.

Unit II

Transportation Problem. Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.

Unit III

Assignment model. Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem. Sequencing models. Solution of Sequencing Problem – Processing n Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machine.

Unit IV

Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problem.

Text Books

1. P. Sankara Iyer, "Operations Research", Tata McGraw-Hill, 2008.
2. A. M. Natarajan, P. Balasubramani, A. Tamilarasi, "Operations Research", Pearson Education, 2005

Reference Books

1. J K Sharma. "Operations Research Theory & Applications, 3e", Macmillan India Ltd, 2007.
2. P K. Gupta and D. S. Hira, "Operations Research", S. Chand & Co., 2007.

EN-60421: Climate Change and Carbon Trade **3-1-0 = 4**

Subject Code: *EN-60421*
Subject Name: *Climate Change and Carbon Trade.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Energy and Climate Change, Global Consensus, evidence and predictions and impacts, Clean Energy Technologies, Energy economy, Role of Renewable Energy, Risk and opportunities, GHGs, GHGs emission and energy activities.

Unit II

Dealing with Climate change Consequences, Emission targets, Measures to reduce GHGs, Climate Change Act. International responses, Kyoto Protocol and CDM, CDM activities in Industries.

Unit III

Emission benchmarks, Governments policies for mitigation and adaptation, Price-based mechanisms such as cap-and-trade and carbon taxes. Complementary non-price policies, and concepts of justice that frame the political negotiations.

Unit IV

Carbon Market, Commerce of Carbon Market, Environmental Transformation Fund, Technology Perspective, Strategies for technology innovation and transformation. New carbon taxation, Indian perspective on carbon taxation.

Text Books :

1. J. Chevallier, Econometric Analysis of Carbon Markets, Springer, 2012.
2. W. J. Burroughs, Climate Change: A multidisciplinary approach, 2/E, Cambridge University Press, 2007.

Reference Books/Materials

1. N. Stern, The Economics of Climate Change. Cambridge University Press, New York. 2007.
2. S. Barrett, The Incentive to Supply Global Public Goods. Oxford University Press, Oxford.2007.
3. K. Kapoor, P. Ambrosi, State and Trends Of The Carbon Market (2008). The World Bank, Washington D. C., May 2008. Available at: /http://siteresources. worldbank.org/ NEWS /Resources /State and Trends formatted 06 May10pm.pdf (2008).
4. IPCC (Intergovernmental Panel for Climate Change-2007). Climate Change: Mitigation (2007). Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York, 2007.

EN-60422: CLEAN COAL AND GAS TECHNOLOGY **3-1-0 = 4**

Subject Code: *EN-60422*
Subject Name: *Clean Coal and Gas Technology.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit-I

Coal Utilization, Coal production and utilization trends, Status of coal utilization technology and related operating and environmental problems, Coal qualities and their effect on selection of efficient methods for eco-friendly utilization of coal.

Unit-II

Pre-Combustion Technology, Necessity, Scope and limitations of pre-combustion coal cleaning technology, Washability characteristics and preparation problems related to coal quality, Principles, operations and selection of processes for coal preparation.

Unit III

Plant performance evaluation and forecasting of cleaning results, Environmental problems and related mitigating measures. Combustion and Post-Combustion Technology, Necessity, scope and limitations of combustion

Unit-IV

Clean coal technologies, Developments, Basic principles, operating features of clean coal technologies, Selection, performance and related environmental problems and their control.

Text Books:

1. Qi Aiying, Zhao Bo, Cleaner Combustion and Sustainable World, Springer 2013.
2. B. G. Miller, Clean Coal Engineering Technology, Butterworth-Heinemann, 2010.

Reference Books/Material

1. P. J. Reddy, Clean coal technologies for power generation, CRC Press, 2013.
2. M. Z.Hou, H Xie, P. Were, Proceedingsof the 3rd Sino-German Conference Series: Springer Series in Geomechanics and Geoengineering "Underground Storage of CO_2 and Energy", Goslar, Germany, 2013. ISBN: 978-3-642-37849-2

EN-60423: ADVANCED BIOFUEL TECHNOLOGY **3-1-0 = 4**

Subject Code: *EN-60423*
Subject Name: *Advanced Biofuel Technology.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Biomass Formation, Biomass resources, Classification and characteristics, Techniques for bio-mass assessment, Application of remote sensing in forest assessment, Biomass estimation. Thermo-chemical Conversion, Different processes, direct combustion, incineration, pyrolysis, gasification and liquefaction, Economics of thermo-chemical conversion.

Unit II

Biological Conversion, Biodegradation and biodegradability of substrate, Biochemistry and process parameters of bio-methanation, Biogas digester types, Digester design and biogas utilisation, Chemical kinetics and mathematical modelling of bio-methanation process. Economics of biogas plant with their environmental and social impacts.

Unit III

Bioconversion of substrates into alcohol, Methanol and ethanol Production, organic acids, solvents, amino acids, antibiotics, Chemical Conversion, Hydrolysis and hydrogenation, Solvent extraction of hydrocarbons, Solvolysis of wood, Bio-crude and biodiesel, Chemicals from biomass.

Unit IV

Waste Conversion using Anaerobic digestion of sewage and municipal wastes, Direct combustion of MSW-refuse derived solid fuel, Land fill gas generation and utilization Power generation, Utilisation of gasifier for electricity generation, Operation of spark ignition and compression ignition engine with wood gas, methanol, ethanol and biogas.

Text Books:

1. R.Pogaku, R.HjSarbatly, Advances in Biofuels, Springer, 2013
2. J. W. Lee, Advances Biofuels and Bioproducts, Springer, 2013.

Reference Books:

1. N. G.Halford, A. Karp, Energy Crops, RSC Energy and Environment Series, Volume 3, Springer, 2011.
2. M. A. Borowitzka, Moheimani and Navid R. Algae for Biofuels and Energy, Developments in applied phycology- volume 5, Springer 2013.
3. R. C. Maheswari, Bio Energy for Rural Energisation, Concepts Publication, 1997.

EN-60424: ELECTRICAL SYSTEMS AND CONTROL INSTRUMENTATION 3-1-0 = 4
Subject Code: *EN-60424*
Subject Name: *Electrical Systems and Control Instrumentation.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I
Structure of power system-generation, transmission and distribution subsystems, necessity of different voltage levels, advantage of high voltage transmission, comparison between d.c. and a.c. transmission, different types of substations, equipment used in substations.

Unit II
Advantages Electric Heating, classification of ovens and furnaces, Industrial application areas. Basic principles of Resistance Furnaces, Arc Furnaces, Induction Furnaces and Dielectric Heating. Linear mechanical elements, force-voltage and force-current analogy.

Unit III
Transmission dynamometer, absorption dynamometer, Measurement of thermo-physical properties, instruments for measuring temperature using point contact and non-contact thermocouple and flow measurement, use of intelligent instruments for the physical variables.

Unit IV
Shadow graph, Schlieren interferometer, Laser Doppler anemometer, heat flux measurement, Telemetry in engines, Chemical, thermal, magnetic and optical gas analysers, measurement of smoke, dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

Text Books:

1. A.K.Swahney, P.Swahney, A Course In Electrical And Electronic Measurements And Instrumentation, DhanpatRai Publications, 2012.
2. R.K.Rajput, Mechanical Measurements and Instrumentation: Including Metrology and Control Systems, S.K.kataria and Sons, 2012.
3. K. Ogata, Modern Control Engineering, PHI, 2010.

Reference Books:

1. A.S Morris, R.Langari,Measurement and Instrumentation:Theory and Application, Academic Press, 2011.
2. H.S. kalsi, Electronic Instrumentation, 3/E, TMH, 2010.
3. J.P.Holman, Experimental methods for engineers, TMH, 2007.
4. C.S Rangan, G.R. Sharma and V.S.V. Mani, Instrumentation Devices and Systems, TMH, 2001.
5. J. Nagrath and D. P. Kothari, Electrical machines, TMH, 2010

EN-60425: POWER PLANT TECHNOLOGY **3-1-0 = 4**

Subject Code: *EN-60425*
Subject Name: *Power Plant Technology.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Introduction to different power plants, Load estimation, Load duration curves, Location of power Plants, Effect of variable load on power plant operation, Selection of power plant units, Power plant economics, Introduction to economics of Hydro-Electric Power Plant, Classification of hydro-electric power plant, Site selection, Elements of hydro-electric power plant, Advantages of hydro-electric power plant Hydrographs, Flow duration curves.

Unit II

Steam Power Plants, General layout of steam power plant, Power plant boilers including critical and super critical boilers, Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds,

Unit III

Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant, Diesel and Gas turbine power plant, General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging.

Unit IV

System, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant. Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant, Non- Conventional Power plants, Prospect of renewable energy based power plant.

Text Books:

1. F.T. Morse, Power Plant Engineering, Affiliated East-West Press Pvt Ltd., 2008.
2. R.K. Rajput, A Text Book of Power Plant Engineering, Laxmi Publication, 2008.

Reference Books:

1. A. Arora and D. Kundwar, A Course in Power Plant Engineering, Khanna Publishers, 2000.
2. P.K. Nag, Power Plant Engineering, TMH, 2007.
3. B. Veatach, L.F. Drbal and P. G Boston, Power Plant Engineering, CBS Publishers, 2005.

EN-60426: REFREGERATION AND AIR CONDITIONING **3-1-0 = 4**

Subject Code: *EN-60426.*
Subject Name: *Refrigeration and Air Conditioning*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit 1

Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect and C.O.P., Air Refrigeration cycle, Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART).

Unit II

Vapour Compression System: Single stage system, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate and superheating of refrigerant vapour on C.O.P of the cycle. Actual vapour compression refrigeration cycle, Multi-stage vapour compression system requirement, Removal of flash gas, Inter-cooling, Different configuration of multistage system, Cascade system. Vapour Absorption system,

Unit III

Working Principle of vapour absorption refrigeration system, Comparison between absorption and compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram and Enthalpy – concentration diagram, Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison.

Unit IV

Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants, Introduction to air conditioning, Psychometric properties and their definitions, Psychometric chart, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Selection of inside and outside design conditions, Heat transfer through walls and roofs, Infiltration and ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP).

Text Books:

1. M. Prasad, Refrigeration and Air conditioning, New Age International (P) Ltd., 2006.
2. R. C. Arora, Refrigeration and Air conditioning, PHI, 2010.

Reference Books:

3. R.K Rajput, Refrigeration and Air conditioning, S. K. Kataria and Sons, 2010.
3. P. L. Ballaney, Refrigeration and Air conditioning, Khanna Publishers, 2003.

EN-615 ENERGY LABORATORY -IV **0-0-4 = 2**

Subject Code: *EN-615.*
Subject Name: *Energy Laboratory -IV.*
No. of Hours Per Week: *Practicals-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments:

1. To determine the flame point of fuels using flash point apparatus.
2. To determine the calorific value of fuels using calorimeter.
3. To determine the viscosity of liquid fuels using redwood viscometer
4. To determine the moisture, volatile matter, fixed carbon and ash content of given solid fuel using Proximate analysis.
5. To Perform Ultimate Analysis of a solid fuel.
6. To estimate the flow of biogas from biomass gasifier using bamboo as feedstock.
7. To determine the induction time and oxidation stability of bio-diesel using Rancimat apparatus
8. To prepare variable speed performance test of a multi-cylinder/single cylinder diesel engine and prepare the curves BHP, IHP versus Speed.
9. To prepare variable speed performance test of a multi-cylinder/single cylinder diesel engine and prepare the curves volumetric efficiency and indicated specific fuel consumption versus speed.
10. To determine the Indicated H.P. of I.C. Engine by Morse Test
11. To study the Fuel Supply System of C.I. Engines- Injector and Fuel Pump.
12. To Study the given Gas Turbine Model.

Text Books:

1. W. R. May, The Chemistry of Hydrocarbon Fuel Combustion, Sfa International,2013.
2. W. H. Booth, Liquid Fuel and Its Combustion, Westminster Constable Publication, 2012.
3. V. Ganesan, Internal combustion Engines, 4/E, TMH, 2012.

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Reference Books:

1. D. K. Clark, Fuel: Its Combustion and Economy, Nabu Press, 2010
2. P. Sharma, M.L.Mathur, Internal Combustion Engines, Dhanpat Rai Publications,2010.
3. S.N. Saha, Fuel Combustion Energy Technology, Dhanpat Rai and Sons, 2003.
4. B. K. Sharma, Fuels and Petroleum Processing, Goel publishing, Meerut, 2000.

EN-701: CHEMICAL ENERGY CONVERSION AND STORAGE DEVICES 3-1-0 = 4
Subject Code: *EN-701.*
Subject Name: *Chemical Energy Conversion and Storage Devices.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I
Introduction to electrochemistry and electro catalysts, Classification of batteries, Theoretical cell voltage, capacity and specific energy and energy density of a battery, Electrode processes-electrical double layer capacity, Ionic absorption, mass transport to electrode surfaces, Factors affecting battery performance. Charge-discharge cycle, Depth of Discharge (DOD) and its characteristics in a battery.

Unit II
Primary Batteries, Performance characteristics, working and construction of Zinc-Carbon, Magnesium-Aluminium, Alkaline-Manganese Dioxide and Zinc-Air Batteries, Performance characteristics, working and construction of Secondary Batteries, Lead-Acid, Nickel-Cadmium, Silver oxide and Lithium-ion Batteries.

Unit III
Specific criteria for Battery selection: stand-alone PV systems, small WEG system, Electric vehicles, industry and space application. Battery Bank design criteria. International standards: International Electro-technical Commission (IEC) and American National Standards Institute (ANSI) nomenclature, terminals and marking. Safety issues, handling and maintenance procedures.

Unit IV
Super-capacitors, Chemistry and material properties of electrolyte, Principle and working, Basic thermodynamics, Reaction kinetics, Charge and discharge Cycle, Modelling of super-capacitors, Testing of super-capacitors based on charge-discharge cycle, Cost and system consideration for super-capacitors.

Text Books:
1. R. J. Brodd, Batteries for Sustainability, Springer, 2013.
2. F. S. Barnes, J. G. Levine, Large Energy Storage Systems, CRC Press, 2011.

Reference Books:
1. T. Reddy, Linden's Handbook of Batteries, 4/E, MGH, 2010.
2. R. Huggins, Advanced Batteries: Materials Science Aspects, Springer. 2009.
3. S. J. Sarangpani, A. Kosek and A. B. La, Handbook of Solid State Batteries and Capacitors, World Scientific Publications, USA.1995.

EN-702: WIND, HYDRO AND OCEAN TECHNOLOGY **3-1-0 = 4**

Subject Code: *EN-702.*
Subject Name: *Wind, Hydro and Ocean Technology.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Introduction to Hydro-energy systems, potential site selection, Site selection and civil works, dam size and construction, estimation of power, Overview of micro, mini and small hydro systems, Elements of turbine, Assessment of Hydro Power, Selection and design criteria of turbines, Speed and voltage regulation.

Unit II

Ocean energy resources, ocean energy routes, Principle of ocean thermal energy conversion systems, ocean thermal power plants, Principles of ocean wave energy and tidal energy conversion, Indian perspective for ocean and tidal energy-technical problems and limitations.

Unit III

Wind energy statistics, Measurements and Data Presentation, Wind Turbine Aerodynamics, Momentum Theories, Basics of Aerodynamics, Aerofoils and their Characteristics, HAWT - Blade Element Theory, Prandtl's Lifting Line Theory (prescribed wake analysis), VAWT Aerodynamics, Wind Turbine Loads, Aerodynamic Loads in Steady Operation.

Unit IV

Wind Turbulence, Yawed Operation and Tower Shadow, Sitting-Rotor Selection, Annual Energy Output, Horizontal Axis Wind Turbine (HAWT) Vertical Axis Wind Turbine, Rotor Design Considerations, Number of Blades, Blade Profile of 2/3 Blades and Teetering, Coning, Upwind/Downwind characteristics and properties.

Text Books:

1. M. Majumder, S. Ghosh, Decision Making Algorithms for Hydro-Power Plant Location, Springer, 2013.
2. S. M. Muyeen, Wind energy conversion systems, Springer, 2012.
3. D. A. Spera, Wind Turbine Technology: Fundamental concepts of wind turbine engineering, ASME Press, 2000.
4. R. H. Charlier, Charls W. Finki, Ocean Energy: Tide and Tidal Power, Springer, 2009.

Reference Books:

1. H. J. Wagner, J. Mathur, Introduction to Hydro Energy Systems, Springer 2011.
2. F. Bianchi, D. Battista, M. Hernan, J. Ricardo, Wind Turbine control systems: Principle, Modelling and Gain Scheduling Design, Springer, 2007.
3. I. Munteanu, A.I. Bratcu, N.-A. Cutululis, E.Ceanga, Optimal control of wind energy systems, Springer, 2008.
4. A. Clive Baker, Tidal Power, Peter Peregrinus Ltd. 1991.

EN-70311: DEMAND SIDE MANAGEMENT **3-1-0 = 4**

Subject Code: *EN-70311*
Subject Name: *Demand Side Management.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Introduction to voltage stability, deregulation of the electricity supply industry, power system operation in competitive environment-transmission open access and pricing issues, ancillary services management, reliability and deregulation, power quality issues, application of power system stabilizers (PSS) - multi-phase (six-phase) system, demand side management and energy auditing.

Unit II

Distribution system planning , planning and forecasting techniques, load characteristics, definitions – load forecasting , load management , tariffs-distribution transformers, types - three phase and single phase transformers, connections, dry type and self-protected type transformers, regulation and efficiency-sub transmission lines and distribution sub-stations- distribution substations, bus schemes substation location and rating, primary systems, voltage drop and power loss calculations , capacitors in distribution systems- distribution system protection - distribution system automation, grounding.

Unit III

Economic dispatch problem and methods of solutions, economic importance-generator unit characteristics, economic dispatch problem considering and neglecting transmission losses, iterative and non-iterative methods of solutions, economic dispatch using dynamic programming, economic dispatch versus unit commitment, constraints in thermal and hydro-units, unit commitment solution methods-hydro thermal coordination.

Unit IV

long range and short-range hydro-scheduling, dynamic programming solution to hydro-thermal scheduling, control of generation- models of power system elements, single area and multi area block diagrams, generation control with PID controllers, implementation of automatic generation control (AGC), AGC features- economic dispatch by ANN and GA approaches.

Text Books:

1. Allen J. Wood and B.F. Woolenberg, Power Generation, Operation and Control, 2/E, Wiley India Pvt. Ltd., 2006.

Reference Books:

1. John J. Grainger and William D Stevenson, Power System Analysis, 1/E, McGraw Hill ISE, 2003.
2. PSR Murthy, Operation and Control in Power System, 2/E, BS Publications, 2009.

EN-70312: GREEN BUILDINGS AND PASSIVE ARCHITECTURE **3-1-0 = 4**

Subject Code: *EN-70312*
Subject Name: *Green Buildings and Passive Architecture.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Thermal Properties and Energy content of Building materials - Psychrometry-Comfort conditions – Air conditioning Systems, Lighting and Visual ability-Light sources and Luminaries - Lighting System Design-Day lighting-Lighting Economics and aesthetics-Impacts of lighting efficiency.

Unit II

Thermal comfort-Ventilation and air quality-Air conditioning requirement- visual perception – illumination Requirement-Auditory requirement-Energy Management Options-Energy Audit and Energy Targeting-Technological Options for Energy Management.

Unit III

Passive architecture, Thermal comfort, sun motion, Building orientation and design, passive heating and cooling concepts, thumb rules, heat transfer in buildings, thermal modeling of passive concepts, evaporative cooling, Energy efficient windows and day lighting.

Unit IV

Earth air tunnel and heat exchanger, zero energy building concept and rating systems, Energy conservation building codes, Software for building simulation, Automation and energy management of buildings

Text Books:

1. Kibert C J, Sustainable Construction: Green Building design and delivery, John Wiley and Sons, 2008.
2. Bauer M, Mösle P, Schwarz, M, Green Buildings, Springer 2013
3. Snell C, Callahan T, Building Green, Lark Crafts; 2/E, 2009.

Reference Books:

1. Anupama Kundoo, Sustainable Buildings: Design Manual, TERI, Volume 1-2. (ISBN: 81-7993-053-X) 2004.
2. Passive Solar Design Handbook, Volume 3,Report of U.S. Department of Energy (DOE/CS-0127/3), USDOE, 2011.
3. D. A. Bainbridge, Passive solar architecture: Heating, cooling, ventilation and day-lighting. Chelsea Green Publishing, 2011.
4. Energy Conservation Building Code, Bureau of Energy Efficiency (BEE), GoI, BEE, 2004.

EN-70313: WASTE HEAT RECOVERY **3-1-0 = 4**

Subject Code: *EN-70313*
Subject Name: *Waste Heat Recovery.*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Unit I

Introduction, Topping, Bottoming, Organic Rankine Cycles, Advantages of Cogeneration Technology. Cogeneration Application in various industries like Cement, Sugar Mill, Paper Mill, Sizing of waste heat boilers, Performance calculations.

Unit II

Part load characteristics selection of Co-generation Technology, Financial considerations, Operating and Investment costs of Cogeneration. Recuperators, Regenerators, economizers, Plate Heat Exchangers.

Unit III

Waste Heat Boilers, Classification, Location, Service Conditions, Design Considerations, Unfired combined Cycle, supplementary fired combined cycle, fired combined cycle, Application in Industries. Fluidised bed heat exchangers, heat pipe exchangers, heat pumps, thermic fluid heaters selection of waste heat recovery technologies.

Unit IV

Financial considerations, operations and investment costs of waste heat recovery, Environmental considerations for cogeneration and waste heat recovery - Pollution. Case Study with exapmles of cement and steel manufacturing industries.

Text Books:

1. K. Matsuda, Y. Kansha, C. Fushimi, A. Tsutsumi and A. Kishimoto, Advanced Energy Saving and its Application in Industry, Springer, 2013.
2. De Oliveira Junior, Exergy, Springer, 2013.

Reference Books:

1. M. P. Boyce, Handbook for cogeneration and combined cycle power plants, ASME (ISBN-10: 0791801691), 2001.
2. N. De-Nevers, Air Pollution Control Engineering, MGH, 1995.

EN-714 ENERGY LABORATORY -V **0-0-4 = 2**

Subject Code: *EN-714.*
Subject Name: *Energy Laboratory -V.*
No. of Hours Per Week: *Practicals-4.*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments:

1. To study the performance characteristics of PEMFC.
2. To determine the maximum power output in PEMFC under different moisture conditions
3. To plot the IV curve and study the effect of activation, ohmic and mass transport losses in Fuel Cell
4. To study the charge-discharge cycle of a super-capacitor.
5. To study the charge-discharge cycle of a battery.
6. To study the effect of Spherical model using the sub-sonic wind tunnel
7. To study the effect of Cylindrical model using the sub-sonic wind tunnel
8. To study the effect of Aerofoil model using the sub-sonic wind tunnel
9. To Determine the Lift and Drag in a Spherical model using the sub-sonic wind tunnel
10. To Determine the Lift and Drag in a Cylindrical model using the sub-sonic wind tunnel
11. To Determine the Lift and Drag in a Aerofoil model using the sub-sonic wind tunnel
12. To study the different components of WTG model.

Text Books:

1. M. Majumder, S. Ghosh, Decision Making Algorithms for Hydro-Power Plant Location, Springer, 2013.
2. S. M. Muyeen, Wind energy conversion systems, Springer, 2012.
3. D. A. Spera, Wind Turbine Technology: Fundamental concepts of wind turbine engineering, ASME Press, 2000.
4. F. S. Barnes, J. G. Levine, Large Energy Storage Systems, CRC Press, 2011.

Reference Books:

1. H. J. Wagner, J. Mathur, Introduction to Hydro Energy Systems, Springer 2011.
2. F. Bianchi, D. Battista, M. Hernan, J. Ricardo, Wind Turbine control systems: Principle, Modelling and Gain Scheduling Design, Springer, 2007.
3. I. Munteanu, A.I. Bratcu, N.-A. Cutululis, E. Ceanga, Optimal control of wind energy systems, Springer, 2008.
4. A. Clive Baker, Tidal Power, Peter Peregrinus Ltd. 1991.