

PT. RAVISHANKAR SHUKLA UNIVERSITY

RAIPUR -492010



DEGREE OF

BACHELOR OF VOCATION (B.Voc.)

IN

Renewable Energy Technology & Management

SCHEME AND SYLLABUS

UNDER THE

FACULTY OF SCIENCE

SYLLABUS

(FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2015 – 16 ONWARDS)

Pt. Ravishankar Shukla University

Raipur - 492010 (C.G.), INDIA

www.prsu.ac.in

AUGUST, 2015

Approved on 07th November, 2015 by Board of Studies in Electronics

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BACHELOR OF VOCATION (Renewable Energy Technology & Management)**PROGRAMME STRUCTURE**

Year-1 Semester- I						
Module Code	Name	L	T	P	Credit	Marks
GENERAL EDUCATION COMPONENT						
RETM-101	Applied Physics	2	1	0	3	100
RETM-102	Environmental Studies	2	1	0	3	100
RETM-103	Fundamentals of Electronics	2	1	0	3	100
RETM-104	Business Communication - I	1	1	1	3	100
SKILL COMPONENT						
RETM-105	Energy Sources and Energy Scenario	2	1	0	3	100
RETM-106	Renewable Energy Sources and Technologies-I	1	1	1	3	100
RETM-107	Solar Photovoltaic Technologies-I	2	1	0	3	100
RETM-108	Waste to Energy Conversion Systems	2	1	0	3	100
RETM-109	Laboratory I (Electronics Lab & Photovoltaic Lab)	0	0	12	6	200
	TOTAL				30	1000
Year-1 Semester-II						
GENERAL EDUCATION COMPONENT						
RETM-201	Business Communication - II	2	1	0	3	100
RETM-202	Power Electronics	2	1	0	3	100
RETM-203	Biochemistry	2	1	0	3	100
RETM-204	IT FOR BUSINESS	1	1	1	3	100
SKILL COMPONENT						
RETM-205	Solar Thermal Engineering and Applications	2	1	0	3	100
RETM-206	Concentrating Solar Thermal Power Plants	2	1	0	3	100
RETM-207	Renewable Energy Sources and Technologies-II	2	1	0	3	100
RETM-208	Renewable Energy Resources and improved Energy Utilization	1	1	1	3	100
RETM-209	Laboratory II (Computer lab & RE lab)	0	0	12	6	200
	TOTAL				60	2000

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Year-2 Semester- III						
Module Code	Name	L	T	P	Credit	Marks
GENERAL EDUCATION COMPONENT						
RETM-301	Innovations In Science	2	1	0	3	100
RETM-302	Material Science for Energy Applications	2	1	0	3	100
RETM-303	Electronics and Instrumentation	2	1	0	3	100
RETM-304	Digital Electronics & Fundamentals Of Microprocessor.	1	1	1	3	100
SKILL COMPONENT						
RETM-305	Solar Cell and Photovoltaic Technologies	2	1	0	3	100
RETM-306	Programming C++/Java	1	1	1	3	100
RETM-307	Smart and Micro-grid	1	1	1	3	100
RETM-308	Energy Storage Systems	2	1	0	3	100
RETM-309	Laboratory III(Digital Electronics & RE lab)	0	0	12	6	200
Year-2 Semester-IV						
GENERAL EDUCATION COMPONENT						
RETM-401	Life Coping Skills	1	1	1	3	100
RETM-402	Applied Mathematics I	2	1	0	3	100
RETM-403	Basic Electrical Engineering Systems	2	1	0	3	100
RETM-404	Project Writing I	1	1	1	3	100
SKILL COMPONENT						
RETM-405	Energy Management and Auditing	1	1	1	3	100
RETM-406	Solar Photovoltaic Power Plants	2	1	0	3	100
RETM-407	Engineering Drawing	2	1	0	3	100
RETM-408	Wind Energy Conversion Systems	2	1	0	3	100
RETM-409	Workshop Practices I/Minor Project	0	0	12	6	200
	TOTAL				60	2000

Year-3 Semester-V						
Module Code	Name	L	T	P	Credit	Marks
GENERAL EDUCATION COMPONENT						
RETM-501	Project Writing II	1	1	1	3	100

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SKILL COMPONENT						
RETM-502	Energy in Buildings	2	1	0	3	100
RETM-503	Energy Efficiency in Electrical Utilities	2	1	0	3	100
RETM-504	Other Renewable Energy Systems	2	1	0	3	100
RETM-505	Hydrogen Energy and Fuel Cells	2	1	0	3	100
RETM-506	Energy Modelling and Project Management	2	1	0	3	100
RETM-507	Energy Economics and Planning	2	1	0	3	100
RETM-508	Energy Efficiency in Thermal Utilities	2	1	0	3	100
RETM-509	Workshop Practices II	0	0	12	6	200
Year-3 Semester-VI						
GENERAL EDUCATION COMPONENT						
RETM-601	Industrial Training	0	0	20	10	350
RETM-602	Major Project	0	0	40	20	650
TOTAL					60	2000

SEMESTER I (Certificate Course)

This course is designed to give you an insight in to the world of renewable energy technologies. You will get a chance to investigate all aspects of renewable energy. In this programme you will explore:

- * Solar energy and its thermal and photovoltaic application
- * Details of passive solar architecture
- * Wind technologies
- * Various biomass to energy routes
- * Small hydro technologies
- * Geothermal, tidal, wave ocean energy technologies
- * Hydrogen and fuel cell

RETM-101 Applied Physics

Unit -1

Electric Current and Ohm's Law: Electron Drift Velocity-Charge Velocity and Velocity of Field Propagation- Electric Potential - Conductance and Conductivity- Ohm's Law Resistance in Series- in Parallel-Types of Resistors-Nonlinear - Varistor-Short and Open Circuits- Series Circuit-Equivalent Resistance-Relative Potential-Voltage Divider Circuits

Unit - 2

Electrostatics: Static electricity-Absolute and Relative Permittivity of a Medium-Laws of Electrostatics-Electric Field-Electrostatic Induction-Electric Flux and Faraday Tubes-Electric Flux Density - Electric Displacement D-Gauss Law- Poisson and Laplace-Electric Potential and Energy-Potential and Potential Difference-Potential at a Point-Potential of a charged sphere-Equi potential Surfaces-Voltage and Dielectric Strength-Boundary Conditions

Unit - 3

Electromagnetic Induction: Relation between Magnetism and Electricity-Production of

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Induced E.M.F. and Current-Faraday's Laws of Electromagnetic Induction- Lenz's Law
Induced E.M.F.-Dynamically-Statically-induced E.M.F.-Self-Inductance-Coefficient of Self
Inductance (L)-Mutual Inductance-Coefficient of Mutual Inductance (M)-Coefficient of
Coupling-Inductances in Series and Parallel

Unit – 4

Magnetic Hysteresis- Area of Hysteresis Loop Properties and applications of Ferromagnetic
Materials-Permanent magnet materials-Steinmetz Hysteresis Law-Energy Stored in
Magnetic Field-Rate of Change of Stored Energy- - Lifting Power of Magnet-Rise and Decay
of Current in Inductive Circuit- Transient Current Rise and decay R-L Circuit -Automobile
Ignition System

References

1. Electrical Technology, Naidu-Kamakshiah, Tata McGraw-Hill Education, 2006
2. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI Learning Pvt. Ltd.,2005
3. A Text Book of Electrical Technology, B.L. Theraja, S. Chand Limited, 2008
4. Photovoltaics: Design and Installation Manual, Solar Energy International, 2012

Module RETM – 102 ENVIRONMENTAL STUDIES

Unit I

Learning Objectives:

1. To familiarize students to the basic concepts of Environmental studies.
2. To help students develop their own perspectives around environmental issues.
3. To enable students to take practical steps to conserve the environment.

Number of lectures: 45

UNIT 1

Environment [12 lectures]

- a. Definition and Composition – Lithosphere, Hydrosphere, Atmosphere, Biosphere, Hydrological Cycle
- b. Historical Development and Approaches
- c. Man and Nature relation and interaction with respect to Food, Clothing, Shelter and Occupation: Concept of Ecology and Ecosystem.

UNIT 2

Resources and Wealth [12 lectures]

- a. Meaning, Types of Resources, Exploitation of Resources, use of Technology and its Impact on Natural Environment
- b. Wealth – meaning, Distinction between wealth and resources, Optimum Conversion of Resources into wealth
- c. Anthropogenic Waste – its effects, Man-made Industrial waste.

UNIT 3

Environmental Degradation [12 lectures]

- a. Meaning, causes : Degradation of Urban Land, Forest and Agricultural Land due to natural causes and human interference.

- b. Global Warming : Problems of non-degradable Waste – Electronic Devices, Plastic and Man- made fibres.
- c. Environmental Assessment – Environmental Impact Assessment (EIA), Environmental Auditing, Environmental Legislation in India, Carbon Bank.

UNIT 4

Environmental Management [9 lectures]

- a. Meaning, development and environmental linkages.
- b. Environmental concerns in India. The need for sustainable development.
- c. Actions for environmental Protection: national and international initiatives, emerging environment management strategies, Indian initiatives.
- d. Environmental Protection Movements and NGOs in India.

Continuous Internal Assessment: Projects / Presentations / Tests

List of Recommended Reference Books:

R. Rajagopalan, R. (2005) *Environmental Studies – From Crisis to Cure*. Delhi: OUP

Additional reading:

- Guha Ramachandra Environmentalism: A global history (OUP) (2000)
- Movies:
- An Inconvenient Truth, Al Gore
- The 11th Hour, Leonardo DiCaprio
- The Age of Stupid. Franny Armstrong.
- Baraka, Ron Fricke.
- Climate change: An Untold Story [Climate's First Orphans; The Weeping Apple Tree; A Degree of Concern; A Green Agony], Discovery Channel.
- Liquid city--Mathew Gandy.
- Story of Stuff --Free Range Studios Tides Foundation.
- Story of bottled water---Free Range Studios Tides Foundation

RETM-103: Fundamentals of Electronics

Unit – 1

Electronics – Introduction- Applications-Current and Voltage Source-Physics of Semiconductor Materials –Structure of Atom-Energy band gap diagram of Conductors, Semiconductors and Insulators

Unit – 2

Semiconductor Diode: Types of semiconductors – P & N Types – charge carriers –P &N Junction theory-VI characteristics –ideal diode-Rectifiers-types of rectifiers- Filters-C, LC and π – Regulators – Zener diode -voltage Regulator, Series voltage Regulator Different types of filters- clipping and clamping circuits –LED-7-segment –Photo diode-LDR

Unit - 3

~~Transistor~~-amplifying action-transistor configuration:-CB, CE, CC Configurations-comparison-thermal runaway-heat sink- Transistor ratings -Transistor biasing and stabilization -selection of operating point-different biasing circuits
FET - Introduction, Types, construction, operation, characteristics - FET Parameters- Comparison between FET and BJT- JFET, MOSFET - UJT Characteristics, features and Applications

Unit - 4

Storage Batteries

Introduction, Types of Batteries primary and Secondary Batteries-Classification of Secondary Batteries base on their Use-Classification of Lead Storage Batteries Battery life and DOD, Battery Charging, State of Charge, Effect of temperature, Battery for Photovoltaic applications, Battery aging, important guidelines

References

1. Basic Electronics and Linear Circuits, Bhargava, Kulshreshtra & Gupta Tata McGraw-Hill Publishing Ltd. 2007
2. Applied Electronics, R S Sedha, S. Chand and Company Ltd. 2008
3. Principles of Electronics, V.K. Mehta, S.Chand and Company Ltd.2005
4. Electronics Service Technology Vol-1. Saji A.G,Shyam Mohan , Ayodhya publications, 2007
5. Integrated Electronics, Jacob Millman and C. Halkias Mill, Tata McGraw-Hill Publishing Ltd. 2008
6. Science & Technology of Photovoltaics P Jayrama Reddy, BS Publications ,CRC Press 2010
7. Solar Electricity Handbook - 2012 Edition: A Simple Practical Guide to Solar Energy - Designing and Installing Photovoltaic Solar Electric Systems, Michael Boxwell, Greenstream Publishers, 2012
8. Photovoltaics: Design and Installation Manual, Solar Energy International, 2012
9. Solar Electric Handbook: Photovoltaic Fundamentals and Applications, Solar Energy International, 2012

RETM-104 AECC: BUSINESS COMMUNICATION - I

LEARNING OBJECTIVE:

The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions

- To enable students to have firm grounding in English to be able to use it effectively in professional as well as social contexts.
- To work towards strengthening the learning process of English language so that our graduates can find their feet in the fiercely competitive job market.

Unit-1 Introducing Professional English Total Lectures: 09

1. Theory of Communication, Types and modes of Communication
2. Oral communication in English

3. Monologue, Dialogue, Group Discussion, Effective Communication/ Mis-Communication
4. English phonology
5. Intonation patterns in English
6. Intra-personal, Inter-personal and Group communication

Unit-2 Current Usage of English Grammar Total Lectures: 18

1. auxiliaries
2. tense and aspect
3. interrogative and negative sentences
4. the positive
5. conditionals
6. Concord

Unit-3 Vocabulary Total Lectures: 09

1. Verbal and Non-verbal (Spoken and Written) Personal, Social and Business
2. Phrasal Verbs
3. Idioms
4. Collocations

Unit-4 Written Business Communication Total Lectures: 09

1. Email Etiquette
2. Professional Presentations
3. Writing Skills: Documenting, Report Writing, Making notes, Letter writing
Writing a Resume, Writing- Memo, Cover Letter

Continuous Internal Assessment

Classroom Practice:

- Greeting and introducing.
- Practicing Short Dialogues.
- Group Discussions, Seminars/Paper-Presentations.
- Listening News/Conversations/Telephonic Conversation.

Recommended Readings:

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas
5. Department of Humanities and Social Sciences, Anna University, 'English for Engineers and Technologists', Vols. I & II (Combined Edition), Orient Longman Pvt. Ltd., 2006.
6. IALA, PUSHP and Sanjay Kumar. 'Communicate or collapse: a handbook of effective public speaking, group discussions and interviews'. PHI Learning Pvt. Ltd., 2007.
7. ILM Prasad, 'How to prepare for Group Discussion and Interview'. Tata McGrawHill, 2001
8. Career Press Editors, '101 Great Resumes', Jaico Publishing House, 2003.

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9. R.S. Aggarwal, 'A Modern Approach to Verbal & Non-Verbal Reasoning', S. Chand & Co, 2004.
 10. Mishra Sunita and Muralikrishna, 'Communication Skills for Engineers', 1st Edition. Pearson Education, 2004.

Module RETM – 105: Energy Sources and Energy Scenario

Unit I

Introduction to Energy

Definition and units of energy and power, Conversion, Energy terms, calorific value, Forms of energy, Classification of energy sources Quality and concentration of energy sources, Energy and Thermodynamics, Energy parameters, Conservation of energy, Energy flow diagram to the earth. Origin of fossil fuels, Time scale of fossil fuels, Role of energy in economic development and social transformation, Energy security.

Unit II

Energy and Growing Economy

Commercial energy production, Final energy consumption, Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy conservation and its importance, Energy strategy for the future, Energy Conservation Act-2001 and its features.

Unit III

Global Energy Scene

Energy consumption in various sectors, projected energy consumption for the next century, exponential increase in energy consumption, energy resources, coal, oil, natural gas, nuclear power and hydroelectricity, impact of exponential rise in energy consumption on global economy, future energy options.

Unit IV

Indian Energy Scene

Commercial and non-commercial forms of energy, energy consumption pattern and its variation as a function of time, India's Power Scene, Gas-Based Generating Plants, Nuclear Power Programme, urban and rural energy consumption, energy as a factor limiting growth, need for use of new and renewable energy sources, Socio-economic impacts, Rural development, Poverty alleviation, Employment; Security of supply and use. Environmental and ethical concerns, Economical aspects of renewable energy systems vs large hydro and thermal power projects.

References

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1. Bani P. Banerjee, Energy and the Environment in India, Oxford University Press, New Delhi.
2. G. D. Rai, Non- conventional Sources of Energy, Khanna Publishers, Delhi.
3. Gopal kumar, Energy Independence Vision of a Hybrid, Unbound Future, Deep and Deep Publications Pvt. Ltd., New Delhi.
4. D. K. Asthana, Meera Asthana, Environment Problems and Solutions, S. Chand and Company Ltd., New Delhi.
5. Abdul Mubeen, M. Emran Khan, M. Muzaffarul Hasan, Energy and Environment, Anamaya Publishers, New Delhi.
6. Upender Pandel, M. P. Poonia, Energy Technologies for Sustainable Development, Prime Publishing, Ghaziabad (UP).
7. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)

Module RETM – 106: Renewable Energy Sources and Technologies

Unit I

Introduction to Non-conventional energy sources, Solar energy, Wind energy/power, Energy from biomass and biogas, Ocean energy ,Wave energy, Tidal energy/power, Geothermal energy, Hydrogen energy, Thermo-electric power, Fuel cell, Magneto-Hydro-dynamic (MHD) generator

Unit II

Renewable and Non-renewable energy sources: Renewable (Non-conventional) energy sources, Non-renewable energy sources, Alternative energy sources, Energy Scenario in India context, Electricity Generation from Non-conventional energy sources, Impact on environment, Fuels, Classification of fuels, Solid fuels ,Liquid fuels, Gaseous fuels

Unit III

SOLAR THERMAL TECHNOLOGIES: Solar Thermal Energy Systems: Absorption and Radiation, Heat Gain and Loss, Solar Cooking Systems ,Principle of Cooking, Cooking by Boiling, Speed of Cooking, Energy Required for Cooking, Types of Solar Cooker, Solar Distillation System , Distillation: Natural Process for Purifying Water

Unit IV

WIND ENERGY: Wind Flow, Motion of Wind , Vertical Wind Speed Variation, Distribution of Wind Speeds, Power in the Wind, Conversion of Wind Power: Wind Turbine, Efficiency of Wind Power Conversion, Co, Types of Wind Turbines, Components of a Wind Turbine, Worldwide Wind Installations

Wind Turbine Sizing and systems Design , Energy Derived from a Wind Turbine

Text Books:

1. Renewable Energy Technologies: A Practical Guide for Beginners, Chetan Singh Solanki, PHI| School Books (2008)
2. Fundamentals of Renewable Energy Systems Paperback – D. Mukherjee, New Age International Publisher; First edition (2011)
3. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
4. G. D. Rai, Non- conventional Sources of Energy, Khanna Publishers, Delhi.

Module RET – 107: Solar Photovoltaic Technologies

Unit-1

SOLAR RADIATION: Solar Spectrum, Extraterrestrial Radiation, Radiation on the Earth Surface, Global, Direct and Diffuse Solar Radiation, Solar Radiation at a Given Location, Annual Variation in Solar Radiation, Optimal Tilt for Solar Equipment, Monthly Averaged Global Radiation at Optimal Tilt

Unit-2 Fundamentals of Solar Cells : Characteristics of semiconductors, Differences between semiconductors, insulators and conductors Theory of p n junction, Principle of operation of p-n junction Solar Cell, I-V Characteristics Solar Cell parameters ,Voc, Isc, FF ,conversion efficiency and power output of solar cell ,Status of Photovoltaic Technologies.

Unit-3

SOLAR PHOTOVOLTAIC TECHNOLOGIES: Solar PV Technology: Advantages and Limitations, Brief History of the Technology, Basics of Technology, the Amount of Power Generated, the Rated Power and Actual Power from a Module, Generating More Power Using Solar PV, Protection of Solar Cells

Unit 4

Solar PV Systems and their applications : Solar PV Module Ratings and Cost, Battery Ratings and Cost, Inverter Ratings and Cost, Maximum Power Point Tracking (MPPT), Solar PV Lantern, Design and Costing, Stand-alone PV System: Home Lighting and Other Usage, Solar PV System Designing , Case Study, Cost Estimation of a PV System

References

1. Renewable Energy Technologies: A Practical Guide for Beginners, Chetan Singh Solanki, PHI| School Books (2008)
2. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki PHI; 3 edition 2015
3. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
4. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, Chetan Singh Solanki PHI (1 January 2013)
5. Fundamentals of Renewable Energy Systems Paperback – D. Mukherjee, New Age International Publisher; First edition (2011)
6. Science & Technology of Photovoltaics P Jayrama Reddy, BS Publications ,CRC Press 2010

7. From Sunlight to Electricity: A Practical Handbook on Solar Photovoltaic Applications, Suneel Deambi, The Energy and Resources Institute, TERI (30 January 2009)

RETM-108 Waste to Energy Conversion Systems

Unit I

Introduction

Introduction to waste and waste processing, Definitions, sources, types and composition of various types of wastes; Characterization of Municipal Solid Waste (MSW), Industrial waste and Biomedical Waste (BMW), Waste collection and transportation; Waste processing-size reduction, Separation; Waste management hierarchy, Waste minimization and recycling of MSW; Life Cycle Analysis (LCA), Material Recovery Facilities (MRF), Recycling processes of solid waste.

Unit II

Waste Treatment and Disposal

Aerobic composting, Incineration, different type of incineration; medical and pharmaceutical waste incinerations, Landfill classification, types, methods and siting consideration, layout and preliminary design of landfills: composition, characteristics, generation, movement and control of landfill leachate and gases, environmental monitoring system for land fill gases, Rules related to the handling, treatment and disposal of MSW and BMW in India.

Unit III

Waste to Energy Conversion Technologies

Sources of energy generation, incineration, gasification of waste using gasifiers, briquetting, utilization and advantages of briquetting. Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, land fill gas generation and utilization.

Unit IV

Environmental and Commercial Aspects of Waste to Energy

Present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages, Environmental and health impacts of incineration and other waste to energy conversion systems, case studies of commercial waste to energy plants, Strategies for reducing environmental impacts.

Text Books:

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1. Gary C. Young, Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, ISBN: 9780470539675, John Wiley and Sons.
 2. Velma I. Grover and Vaneeta Grover, Recovering Energy from Waste Various Aspects, ISBN 978-1-57808-200-1.
 3. Shah, Kanti L., Basics of Solid and Hazardous Waste Management Technology, Prentice Hall.
 4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers.
 5. Marc J. Rogoff, Waste-to-Energy, Elsevier.
 6. Parker, Colin and Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London.
 7. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House.
 8. Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi.

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Semester-I

RETM-109 LABORATORY –I (6 credits)

LAB A : Electronics Lab

PRACTICALS (*ELECTRONICS*)

1. Study of forward and reversed biased characteristics of PN Junction Diode
2. Study of breakdown characteristics and voltage regulation action of Zener diode.
3. Study of half wave & full wave rectifier
4. To study and observe waveform at the output of half wave rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor.
5. Study of Capacitor input, L section and π section filter
6. Study of output characteristics of Bipolar Junction Transistor in CE mode.
7. Study of output and transfer characteristics JFET/ MOSFET.
8. Study of I-V characteristics of UJT and UJT based relaxation oscillator.
9. Study of I-V characteristics of SCR.
10. Design, build and test Low pass and High pass RC filters.
11. Study of Low voltage Half – wave, Full – wave and Bridge rectifier circuits.
12. Study of switching and amplification actions of BJT and JFET/ MOSFET
13. Study of potential divider biasing of BJT and its use in DC motor driving.

LAB B: Photovoltaic Laboratory

1. Identifying and Measuring the Parameters of Solar PV Module in the Field
2. Series and Parallel Connection of PV Modules
3. Estimating the Effect of sun Tracking on Energy Generation by Solar PV Modules
4. Efficiency Measurement of Standalone Solar PV System
5. Dark and Illumination Current-Voltage Characteristics of Solar Cell
6. Solar Cells Connected in series and in Parallel
7. Dependence of Solar Cell I-V Characteristics on Light Intensity and Temperature
8. Carrier Lifetime Measurements for a Solar Cell
9. Spectral Response Measurement
10. Solar Cell Simulation Using PC1D Simulator
11. SEQUEL: Using the GUI
12. Find the MPP manually by varying the resistive load across PV panel
13. Find the MPP by varying the duty cycle of the DC-DC converter
14. Observe the V_m , I_m , P_m and duty cycle at which MPP occurs, with MPP algorithm
Observe the response of P_m in the Plotter and compare with the P_m observed in the experiment