

**ANNA UNIVERSITY, CHENNAI**  
**NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY**  
**M.E. ENERGY ENGINEERING**  
**REGULATIONS 2021**  
**CHOICE BASED CREDIT SYSTEM**  
**I TO IV SEMESTERS CURRICULA AND I SEMESTER SYLLABI**

**SEMESTER I**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EY4101	Energy Management and Environmental Benefits	PCC	3	0	0	3	3
2.	EY4102	Fluid Mechanics and Heat Transfer	PCC	3	1	0	4	4
3.	EY4103	Instrumentation for Energy Systems	PCC	3	0	0	3	3
4.	EY4104	Renewable Energy Systems	PCC	3	0	0	3	3
5.	EY4105	Thermodynamic Analysis of Energy Systems	PCC	3	1	0	4	4
6.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICAL								
8.	EY4111	Renewable Energy Laboratory	PCC	0	0	4	4	2
9.	EY4112	Applied Thermal Engineering Laboratory	PCC	0	0	4	4	2
TOTAL				19	2	8	29	23

\*Audit Course is optional.

### SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EY4201	Energy Conservation in Industrial Utilities	PCC	3	0	0	3	3
2.	EY4202	Computational Fluid Dynamics for Energy Systems	PCC	3	1	0	4	4
3.	EY4203	Energy Efficient Buildings Design	PCC	3	0	0	3	3
4.		Professional Elective - I	PEC	3	0	0	3	3
5.		Professional Elective – II	PEC	3	0	0	3	3
6.		Audit Course – II*	AC	2	0	0	2	0
PRACTICAL								
7.	EY4211	Energy Conservation Laboratory	PCC	0	0	4	4	2
8.	EY4212	Analysis and Simulation Laboratory for Energy Engineering	PCC	0	0	4	4	2
9.	EY4213	Mini Project with Seminar	EEC	0	0	4	4	2
TOTAL				17	1	12	30	22

\*Audit Course is optional.

### SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective - III	PEC	3	0	0	3	3
2.		Professional Elective - IV	PEC	3	0	0	3	3
3.		Professional Elective - V	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
5.	EY4311	Project Work – I	EEC	0	0	12	12	6
TOTAL				12	0	12	24	18

### SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	EY4411	Project Work – II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75**

**PROFESSIONAL ELECTIVE COURSES****SEMESTER II, ELECTIVE I**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY4073	Design and Analysis of Turbomachines	PEC	3	0	0	3	3
2.	EY4075	Fluidized Bed Systems	PEC	3	0	0	3	3
3.	EY4072	Bio Energy Technologies	PEC	3	0	0	3	3
4.	EY4074	Energy Forecasting, Modeling and Project Management	PEC	3	0	0	3	3

**SEMESTER II, ELECTIVE II**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY4001	Modeling and Analysis of Energy Systems	PEC	3	0	0	3	3
2.	EY4002	Power Generation, Transmission and Distribution	PEC	3	0	0	3	3
3.	EY4003	Nuclear Engineering	PEC	3	0	0	3	3
4.	EY4076	Solar Energy Technologies	PEC	3	0	0	3	3

**SEMESTER III, ELECTIVE III**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY4071	Advanced Energy Storage Technologies	PEC	3	0	0	3	3
2.	TE4072	Design of Heat Exchangers	PEC	3	0	0	3	3
3.	IC4073	Hybrid and Electric Vehicles	PEC	3	0	0	3	3

**SEMESTER III, ELECTIVE IV**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY4004	Power Electronics for Renewable Energy Systems	PEC	3	0	0	3	3
2.	EY4005	Wind Energy systems	PEC	3	0	0	3	3
3.	TE4071	Advanced Power Plant Engineering	PEC	3	0	0	3	3

### SEMESTER III, ELECTIVE V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY4006	Hydrogen and Fuel Cell Technologies	PEC	3	0	0	3	3
2.	EY4007	Smart Grid	PEC	3	0	0	3	3
3.	EY4008	Environmental Engineering and Pollution Control	PEC	3	0	0	3	3
4.	MF4072	Industrial Safety	PEC	3	0	0	3	3

### AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

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PROGRESS THROUGH KNOWLEDGE

<b>EY4101</b>	<b>ENERGY MANAGEMENT AND ENVIRONMENTAL BENEFITS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **COURSE OBJECTIVES:**

1. To create awareness on the energy scenario of India with respect to world
2. To learn the methodology adopted for an energy audit
3. To appreciate the concepts adopted in project management
4. To study the different techniques adopted for financial appraisal of a project
5. To Comprehend the impact of energy on environment

### **UNIT– I ENERGY SCENARIO 9**

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing –energy security-energy conservation and its importance -EnergyConservationAct2001

### **UNIT– II ENERGY MANAGEMENT 9**

Energy audit - need – types – methodology – barriers - analysis on energy costing and sharing - bench marking - fuel and energy substitution – billing parameters in TANGEDCO – demand side management - instruments for energy audit – energy monitoring and targeting – CUSUM – energy labeling

### **UNIT–III PROJECT MANAGEMENT 9**

Four Basic Elements of Project Management - Project Management Life Cycle - Steps in Project Management Project Definition and Scope, Technical Design, Financing, Contracting, Implementation Techniques (Gantt Chart, CPM and PERT) and PerformanceMonitoring-EnMS5001

### **UNIT– IV FINANCIAL MANAGEMENT 9**

Investment appraisal for energy conservation projects - Financial analysis techniques -Simple payback period, Return on investment, Net present value, Internal rate of return - Cash flows – Risk and sensitivity analysis: micro and macro factors- Financing options- energy performance contracts-ESCOs.

### **UNIT– V ENERGY AND ENVIRONMENT 9**

Greenhouse effect and the carbon cycle - current evidence and future effects of climate change - Global Environmental Concerns-United Nations Frame work Convention on Climate Change(UNFCCC), Kyoto Protocol, Conference of Parties(COP), Emissions trading(ET), Joint implementation(JI), Clean Development Mechanism (CDM), Proto type Carbon Fund(PCF), Sustainable Development

**TOTAL: 45 PERIODS**

### **COURSE OUTCOMES:**

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

1. Recognize the importance of energy conservation and suggest measures for improving per capita energy consumption
2. Analyse the energy sharing and cost sharing pattern of fuels used in industries
3. Apply Gantt Chart, CPM and PERT in energy conservation projects
4. Evaluate the techno-economics of a project adopting discounting and non-discounting Cash flow techniques
5. Assess the sources of additional revenue generation for energy conservation projects Adopting UNFCC

## REFERENCES:

1. Energy Manager Training Manual (4 Volumes) available at <http://www.em-ea.org/gbook1.asp>, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India. 2004.
2. L.C. Witte, P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
3. W.C. Turner, "Energy Management Hand book" Wiley, New York, 1982
4. W.R. Murphy and G. McKay "Energy Management" Butterworths, London 1987
5. Eastop, T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.

<b>EY4102</b>	<b>FLUID MECHANICS AND HEAT TRANSFER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

## COURSE OBJECTIVES:

1. To make students familiarize with the application of conservation equations
2. To explain the incompressible and compressible fluid flow concepts
3. To inculcate the analysis of conduction and gas radiation heat transfer
4. To provide the details of turbulent forced convective heat transfer
5. To impart the knowledge of design of single phase and multi-phase heat exchangers

### UNIT- I BASIC EQUATION, POTENTIAL FLOW AND BOUNDARY LAYER THEORY 12

Three dimensional forms of governing equations – Mass, Momentum and Energy equations and their engineering applications. Rotational and irrotational flows – vorticity – stream and potential functions. Boundary Layer – displacement, momentum and energy thickness – laminar and turbulent boundary layers in flat plates and circular pipes.

### UNIT- II INCOMPRESSIBLE AND COMPRESSIBLE FLOWS 12

Laminar flow between parallel plates – flow through circular pipe – friction factor – smooth and rough pipes – Moody diagram – losses during flow through pipes. Pipes in series and parallel – transmission of power through pipes. One dimensional compressible flow analysis – flow through variable area passage – nozzles and diffusers.

### UNIT-III CONDUCTION AND RADIATION HEAT TRANSFER 12

Governing Equation and Boundary conditions, Extended surface heat transfer, Transient Conduction – Use of Heisler -Grober charts, Conduction with moving boundaries, Stefan and Neumann problem – Gas Radiation.

### UNIT- IV TURBULENT FORCED CONVECTIVE HEAT TRANSFER 12

Turbulence theory – mixing length concept – turbulence model –  $k-\epsilon$  model – analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube – high speed flows.

### UNIT- V PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 12

Condensation on bank of tubes – boiling – pool and flow boiling, Heat exchanger –  $\epsilon$  – NTU approach and design procedure – compact heat exchanger.

**TOTAL: 60 PERIODS**

## COURSE OUTCOMES:

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

1. Identify, formulate and analyze the governing equations for various engineering Applications
2. Explain the flow concepts of incompressible and compressible flow.
3. Solve the conduction and radiation heat transfer problems.
4. Infer the turbulent forced convective heat transfer
5. Design a heat exchanger as per the industrial needs.

## REFERENCES:

1. Yunus A Cengel and John M Cimbala, "Fluid Mechanics Fundamentals and Applications," TMH Ltd., Second Edition, 2006.
2. ShivKumar, "Fluid Mechanics Basic Concepts & Principles" Ane Books Pvt. Ltd, Second Edition 2011.
3. Venkateshan SP., "Heat Transfer" Ane Books Pvt. Ltd, 2011
4. Holman JP, "Heat Transfer", TMH Ltd., Ninth Edition, 2010.
5. Ozisik MN., "Heat Transfer—A Basic Approach", McGraw Hill Co, 1985.

EY4103

## INSTRUMENTATION FOR ENERGY SYSTEMS

L	T	P	C
3	0	0	3

## COURSE OBJECTIVES:

1. To impart knowledge about characteristics of measurement system and statistical analysis of Measured data.
2. To make students conversant with the electrical measurements and signal conditioning circuits.
3. To provide insight into the digital measuring techniques of physical quantities and Solar instruments.
4. To make the students get acquainted with the measurement of thermo-physical properties and air pollutants.
5. To inculcate skills in the design and development of measurement and control systems.

## UNIT-I MEASUREMENT SYSTEM: CHARACTERISTICS AND STATISTICAL ANALYSIS 9

Introduction to measurement system, Errors in Measurement, Static and Dynamic characteristics of transducers, Statistical analysis of experimental data—Uncertainty analysis, Regression analysis, Design of experiments—Full and Half factorial design.

## UNIT-II ELECTRICAL MEASUREMENTS AND SIGNAL CONDITIONING 9

Voltage, Current, Power, Energy, Time and Frequency measurement, Frequency Counter, Signal conditioning Circuits: Wheatstone bridge—Differential Amplifier—VtoI Converter, ItoV Converter, Integrator, Differentiator, Instrumentation Amplifier, Attenuators and Filters, DAC, ADC, PID Controller.

## UNIT-III DIGITAL MEASUREMENT OF PHYSICAL QUANTITIES 9

Digital measuring techniques of Displacement, Temperature, Pressure, Force, Torque, Vibration, Acceleration, Velocity, Level, Flow, Thermal and Nuclear Radiation. Solar instruments: Pyrheliometers – Pyranometers – Pyrhemometers – Albedometers – Pyrradiometers – Pyrgeometers – Net Pyrradiometers – Sun photometers.



**UNIT– IV      MEASUREMENT OF THERMO-PHYSICAL PROPERTIES AND AIR POLLUTANTS      9**

Measurement of Thermal Conductivity–Solids, Liquids and Gas, Viscosity, Gas Diffusion. Calorimetry – Bomb Calorimeter – Continuous flow Calorimeter. Measurement of Heat Transfer, Humidity, Heat flux, pH, Air pollution Sampling and Measurement–Particulate Sampling techniques –Measurement of Sulphur Dioxide, Combustion products, Opacity and Odour.

**UNIT–V      CONTROL SYSTEMS      9**

Introduction to Controller – Interfacing with I/O devices of system: Sensors, Display devices, Stepper and Servomotors. Measurement by Data Acquisition System. Introduction to Internet of Things (IoT) – Application of IoT with Raspberry Pi for Process monitoring and control–Energy management. PID Controller in thermal systems–Application of Smart Sensors and Intelligent instrumentation and Control.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Analyze and evaluate the uncertainties in measurement data.
2. Identify appropriate sensors for measuring electrical quantities and signal conditioning Circuits.
3. Explain the digital measurement techniques of physical quantities and solar instruments.
4. Compare the thermo-physical properties of air pollutants and identify air pollutant measurement techniques.
5. Design and develop the appropriate measurement and control system for an application.

**REFERENCES:**

1. Barney G.C., "Intelligent instrumentation: microprocessor applications in measurement and Control", Prentice Hall, 1988.
2. Bell C., "Beginning Sensor Networks with Arduino and Raspberry Pi", Apress, 2013.
3. Doebelin E. and Manik D.N., "Doebelin's Measurement Systems", Tata McGraw Hill, 2011.
4. George, B., Roy, J.K., Kumar, V.J., Mukhopadhyay, S.C., "Advanced Interfacing Techniques for Sensors", Springer, 2017.
5. Holman J.P., "Experimental methods for Engineers", Tata McGrawHill, 2007.

PROGRESS THROUGH KNOWLEDGE



**COURSE OBJECTIVES:**

1. To know the present status of Indian and global energy scenario.
2. To learn the various solar energy technologies and its applications.
3. To educate the various wind energy technologies.
4. To explore the various bio-energy technologies.
5. To study the ocean and geothermal technologies.

**UNIT-I ENERGY SCENARIO****9**

Indian energy scenario in various sectors-domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption –Future energy plans

**UNIT-II SOLAR ENERGY****9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum – Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems –Solar PV applications.

**UNIT-III WIND ENERGY****9**

Wind data and energy estimation – Betz limit – Site selection for wind farms – characteristics – Wind resource assessment – Horizontal axis wind turbine – components – Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems-Environmental issues-Applications.

**UNIT- IV BIO-ENERGY****9**

Bio resources – Biomass direct combustion – thermochemical conversion – biochemical conversion-mechanical conversion – Biomass gasifier – Types of biomass gasifiers –Cogeneration – Carbonisation – Pyrolysis – Biogas plants – Digesters –Biodiesel production – Ethanol production –Applications.

**UNIT-V OCEAN AND GEOTHERMAL ENERGY****9**

Small hydro –Tidal energy-Wave energy-Open and closed OTEC Cycles-Limitations –Geothermal energy-Geothermal energy sources – Types of geothermal power plants – Applications-Environmental impact.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

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

1. Illustrate the Indian and global energy scenario
2. Compare various solar energy technologies and identify its applications
3. Infer wind data and compare various wind energy systems.
4. Examine various bio-energy technologies and identify their application.
5. Interpret ocean and geothermal energy conversion technologies.

**REFERENCES:**

1. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press,U.K., 2012.
2. David M. Buchla., "Renewable Energy Systems", pearson education publication, Hard cover/Paperback-2017.
3. Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage",Tata McGraw Hill Publishing Company Ltd., New Delhi,2009.
4. TiwariG.N., "Solar Energy-Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015.

5. Mehmet Kanoglu "Fundamentals and Applications of Renewable Energy", Indian edition McGraw Hill Publication, Hard cover/Paperback-2020.
6. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFN Spon Ltd., UK, 2015.

**EY4105**

**THERMODYNAMIC ANALYSIS OF ENERGY SYSTEMS**

**L T P C**

**3 1 0 4**

**COURSE OBJECTIVES:**

1. To understand, apply and analyze the concept of availability to the thermodynamic systems
2. To understand, study and analyze the behavior of real gas and gas mixtures
3. To understand the applications of first and second law to chemically reacting systems
4. To study, balance and analyze the various combustion aspects of hydrocarbon fuels
5. To apply the concepts of thermodynamics to IC Engines and Gas turbines energy systems

**UNIT- I AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS 12**

Reversible work – availability – irreversibility. Second law efficiency for a closed system and steady – state, control volume. Availability analysis of simple cycles. Thermodynamic potentials. Maxwell relations. Generalized relations for changes in entropy – internal energy and enthalpy – Cp and CV. Clausius Clayperon equation, Joule – Thomson coefficient. Bridgeman tables for thermodynamic relations.

**UNIT- II PROPERTIES OF REAL GAS AND GAS MIXTURES 12**

Different equations of state – fugacity – compressibility. Principle of corresponding States – Use of generalized charts for enthalpy and entropy departure. Fugacity coefficient, Lee – Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition. Partial molar properties. Ideal and real gas mixtures.

**UNIT- III CHEMICAL THERMODYNAMICS AND EQUILIBRIUM 12**

First and second law analysis of reacting systems – Adiabatic flame temperature – entropy change of reacting systems. Criterion for reaction equilibrium. Equilibrium constant for gaseous mixtures and evaluation of equilibrium composition.

**UNIT- IV COMBUSTION CHEMISTRY 12**

Combustion of Hydrocarbon Fuels. Heat of reaction, combustion and formation. Stoichiometric, fuel rich and oxygen rich reactions. Heating value of fuels. Explosion limits, flames and flammability limits. Diffusion and premixed flames.

**UNIT- V COMBUSTION PROCESSES AND COMBUSTION CHAMBERS 12**

Combustion in IC Engines and Gas turbines. Knocking and Detonation and control. Design principles of combustion chambers for IC Engines and Gas turbine. Arrangements of gas turbine combustion – comparative analysis.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

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

1. Explain the availability and entropy of the thermodynamic systems and simple cycles, and apply various thermodynamic relations to arrive at the T-dS relations
2. Examine the behavior of real gas through empirical equations and thermodynamic tables, and calculate the various properties of gas mixtures
3. Apply first and second law to chemically reacting closed and open systems and arrive at the various thermodynamic parameters
4. Calculate the air fuel ratio, chemical composition of combustion products, understand the various levels of air supply to the hydrocarbon fuels and combustion limits
5. Make use of the knowledge of thermodynamics for analyzing the process of combustion and its related parameters in an IC Engine and study the various arrangements of Gas Turbine systems

## REFERENCES:

1. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 1988.
2. Kenneth Wark Jr., Advanced Thermodynamics for Engineers, McGraw – Hill Inc., 1995.
3. Kalyan Annamalai, Ishwar K. Puri, Milind A. Jog., Advanced thermodynamics engineering, CRC press, 2011.
4. Claus Borgnakke, Richard E. Sonntag., Fundamentals of Thermodynamics, John Wiley & Sons, 2009.
5. Ganesan, V., Thermodynamics: Basics and Applied, Tata McGraw Hill, 2018.
6. Natarajan, E., Engineering Thermodynamics – Fundamentals and Applications, Anuragam Publications, 2014.
7. Rao, Y. V. C., Chemical Engineering Thermodynamics, University Press, 1997.
8. Kuo, K.K., Principles of Combustion, John Wiley and Sons, 2005.
9. Ganesan, V., Internal Combustion Engines, Tata McGraw Hill, 2006.
10. Ganesan, V., Gas Turbines, Tata McGraw Hill, 2011.

<b>RM4151</b>	<b>RESEARCH METHODOLOGY AND IPR</b>	<b>L T P C</b>
		<b>2 0 0 2</b>
<b>UNIT I</b>	<b>RESEARCH DESIGN</b>	<b>6</b>
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.		
<b>UNIT II</b>	<b>DATA COLLECTION AND SOURCES</b>	<b>6</b>
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.		
<b>UNIT III</b>	<b>DATA ANALYSIS AND REPORTING</b>	<b>6</b>
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.		
<b>UNIT IV</b>	<b>INTELLECTUAL PROPERTY RIGHTS</b>	<b>6</b>
Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.		
<b>UNIT V</b>	<b>PATENTS</b>	<b>6</b>
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.		

**TOTAL : 30 PERIODS**

## REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

**COURSE OBJECTIVES:**

1. To learn the working of different renewable energy devices.
2. To understand the methodology adopted for performance evaluation of various renewable energy systems.
3. To understand the emission from biodiesel engines and biofuel analysis.

**LIST OF EXPERIMENTS**

1. Study on solar radiation measurement devices
2. Performance testing of solar water heater
3. Determining the characteristics of solar photovoltaic materials and estimation of MPP(I-V curve)
4. Performance evaluation of solar cookers (box type and concentrating type)
5. Evaluating and comparing the efficiency of conventional stove and improved (energy efficient) cook stoves.
6. Testing of biomass Gasifier in up draught / down draught mode. Study of biogas plant—fixed dome and floating drum model
7. Proximate analysis of a given biofuel
8. Estimation of calorific value of any solid fuels using bomb calorimeter
9. Computation of calorific value of liquid fuels using Junkers gas calorimeter
10. Synthesis of biodiesel —energy and mass balancing
11. Performance evaluation of engine on biodiesel
12. Comparison of combustion and emissions of B0 and B100

**TAL: 60 PERIODS****COURSE OUTCOMES:**

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

1. Evaluate the performance of renewable energy devices.
2. Analyze the factors influencing the efficiency and suggest methods for improving the
3. Adaptability and efficiency of renewable energy devices.
4. Appraise testing methods and evaluate emissions from renewable energy systems

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES**

1. To educate the students on the realities of thermal engineering.
2. To educate the students about calibration and its essentiality in thermal systems.
3. To Educate the students on thermal engineering concepts

**LIST OF EXPERIMENTS**

1. Experimental Studies on Thermal Boundary Layer for different geometries.
2. Calibration of Temperature Transducers (Thermocouple, RTD & Thermistors).
3. Calibration of Pressure Transducers.
4. Experimental Analysis of Organic Rankine Cycle.
5. Fluid and Thermal Transfer Properties of Liquid Fuels/Heat Transfer Fluids.
6. Experimental Studies on Pool Boiling of Water using Flow Visualization Technique.
7. Flow Characteristic occurrence between Bodies in Wind Tunnel.
8. Experimental Studies on Fluidization of Solid Fuels.
9. Studies on Absorption Refrigeration System.
10. Experimental Studies on Drying of Agro Products.
11. Determining the Actual p-v Diagram of an IC Engine.

**TOTAL: 60 PERIODS****COURSE OUTCOMES:**

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

1. Construct the error curve and correction curve for different measuring instruments.
2. Analyze the critical/influential properties of thermal systems.
3. Interpret the heat transfer and mass transfer in thermal devices

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PROGRESS THROUGH KNOWLEDGE

## AUDIT COURSES

**AX4091**

**ENGLISH FOR RESEARCH PAPER WRITING**

**L T P C**  
**2 0 0 0**

### **COURSE OBJECTIVES**

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

### **UNIT-I INTRODUCTION TO RESEARCH PAPER WRITING**

**6**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

### **UNIT-II PRESENTATION SKILLS**

**6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

### **UNIT-III TITLE WRITING SKILLS**

**6**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

### **UNIT-IV RESULT WRITING SKILLS**

**6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

### **UNIT-V VERIFICATION SKILLS**

**6**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

**TOTAL: 30 PERIODS**

### **COURSE OUTCOMES**

- CO 1 –Understand that how to improve your writing skills and level of readability  
CO 2 – Learn about what to write in each section  
CO 3 – Understand the skills needed when writing a Title  
CO 4 – Understand the skills needed when writing the Conclusion  
CO 5 – Ensure the good quality of paper at very first-time submission

### **REFERENCES**

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.



**OBJECTIVES**

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

**UNIT-I INTRODUCTION****6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**UNIT-II REPERCUSSIONS OF DISASTERS AND HAZARDS****6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**UNIT-III DISASTER PRONE AREAS IN INDIA****6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

**UNIT-IV DISASTER PREPAREDNESS AND MANAGEMENT****6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

**UNIT-V RISK ASSESSMENT****6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

**TOTAL : 30 PERIODS****OUTCOMES**

CO 1: Ability to summarize basics of disaster

CO 2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO 3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO 4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO 5: Ability to develop the strengths and weaknesses of disaster management approaches

**REFERENCES**

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company,2007.
3. Sahni, PardeepEt.Al. , " Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi,2001.



**OBJECTIVES**

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

**UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION**

History, Drafting Committee, (Composition & Working)

**UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION**

Preamble, Salient Features

**UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT IV ORGANS OF GOVERNANCE**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

**UNIT V LOCAL ADMINISTRATION**

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Panchayati raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

**UNIT VI ELECTION COMMISSION**

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

**TOTAL: 30 PERIODS**

**OUTCOMES**

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

**SUGGESTED READING**

- The Constitution of India, 1950 (Bare Act), Government Publication.
- Dr. S.N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

## UNIT I

## சங்க இலக்கியம்

6

1. தமிழின் துவக்க நூல் தொல்காப்பியம்  
- எழுத்து, சொல், பொருள்
2. அகநானூறு (82)  
- இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)  
- போரை நிறுத்திய ஔவையார்

## UNIT II

## அறநெறித் தமிழ்

6

1. அறநெறி வகுத்த திருவள்ளுவர்  
- அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து  
- ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

## UNIT III

## இரட்டைக் காப்பியங்கள்

6

1. கண்ணகியின் புரட்சி  
- சிலப்பதிகார வழக்குரை காதை  
சமூகசேவை இலக்கியம் மணிமேகலை  
- சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

## UNIT IV

## அருள்நெறித் தமிழ்

6

1. சிறுபாணாற்றுப்படை  
- பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குத் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை  
- அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)  
- இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு  
- சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு  
நற்றிணை (11) - நண்டு  
கலித்தொகை (11) - யானை, புறா  
ஐந்திணை 50 (27) - மான்  
ஆகியவை பற்றிய செய்திகள்

## UNIT V

## நவீன தமிழ் இலக்கியம்

6

1. உரைநடைத் தமிழ்,  
- தமிழின் முதல் புதினம்,  
- தமிழின் முதல் சிறுகதை,  
- கட்டுரை இலக்கியம்,

- பயண இலக்கியம்,
- நாடகம்,
- 2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
- 3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
- 4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
- 5. அறிவியல் தமிழ்,
- 6. இணையத்தில் தமிழ்,
- 7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

**TOTAL: 30 PERIODS**

**தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்**

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) - [www.tamilvu.org](http://www.tamilvu.org)
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) - <https://ta.wikipedia.org>
3. தர்மபுர ஆதின வெளியீடு
4. வாழ்வியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

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