VIMAL JYOTHI
ENGINEERING COLLEGE (AUTONOMOUS)
CHEMPERI – KANNUR I WWW.VJEC.AC.IN

VJEC B. Tech. Syllabus 2024

Minor
in
Electrical & Electronics Engineering

MINOR DEGREE STRUCTURE

Offered by Department of Electrical and Electronics Engineering

Minor is an additional credential a student may earn if he/she does 15 credits worth of additional learning in a discipline other than her/his major discipline of B. Tech degree. The objective is to permit a student to customize their Engineering degree to suit their specific interests. Upon completion of an Engineering Minor, a student will be better equipped to perform interdisciplinary research and will be better employable. Engineering Minors allow a student to gain interdisciplinary experience and exposure to concepts and perspectives that may not be a part of their major degree programs. The academic units offering minors in their discipline will prescribe the set of courses and/or other activities like projects necessary for earning a minor in that discipline.

Electrical and Electronics Engineering (EEE) is a field that focuses on the design, development, and application of electrical systems and electronic devices, spanning areas like power generation, telecommunications, and automation. The EEE minor program at Vimal Jyothi Engineering College is designed to provide students from other disciplines an opportunity to explore the vast domain of electrical and electronics engineering and equip themselves with essential knowledge and skills in this field.

- **An academic major** is the academic discipline to which an undergraduate student formally commits. A student who successfully completes all courses required for the major qualifies for an undergraduate degree.
- **Academic minor** is an academic discipline outside of the student's academic major in which he or she takes a small number of classes.

Curriculum – Minor in EE

Semester	Course Code	Course Title	L	T	P	R	C	CIA	ESE
S3	MNEET309	INTRODUCTION TO POWER ENGINEERING	3	1	0	0	4	40	60
S4	MNEET409	ENERGY SYSTEMS	3	1	0	0	4	40	60
S5	MNEET509	ELECTRICAL MACHINES/ MOOC	3	1	0	0	4	40	60
S6	MNEET609	SOLAR AND WIND ENERGY CONVERSION SYSTEMS/ MOOC	3	0	0	0	3	40	60
Total Credit							**15**		

SEMESTER S3

INTRODUCTION TO POWER ENGINEERING

Course Code	MNEET309	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	ESE Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST104 Introduction to Electrical & Electronics Engineering/ GCEST204 - Basic Electrical and Electronics Engineering	Course Type	Theory

Course Objectives:

1. To introduce various conventional energy sources for power generation.
2. To understand the economics of power generation and power factor improvement.
3. To design mechanical and electrical parameters of transmission systems.
4. To classify different types of AC and DC distribution systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Generation of power** Conventional sources**:** Hydroelectric Power Plants- Selection of site. General arrangement of hydel plant, Components of the plant, Classification of the hydel plants -Water turbines: Pelton wheel, Francis, Kaplan and propeller turbines, Small hydro generation. Steam Power Plants: Working of steam plant, Power plant equipment and layout, Steam turbines Diesel Power Plant: Elements of diesel power plant, applications Gas Turbine Power Plant: Introduction Merits and demerits, selection site, fuels for gas turbines, General arrangement of simple gas turbine power plant, comparison of gas power plant with steam power plants Nuclear Power Plants: Nuclear reaction, nuclear fission process, nuclear plant layout, Classification of reactors	**10**
2	**Economics of power generation** Types of loads, Load curve, terms and factors, peak load and base load Cost of electrical energy – numerical problems Power factor improvement – causes of low power factor, disadvantages- methods of power factor improvement, calculations of power factor correction, economics of power factor improvement	**10**
3	**Transmission system** Different types of transmission system - High voltage transmission - advantages Mechanical design of overhead transmission line: Main components of overhead lines – types of conductors, line supports Insulators–Types-String efficiency – methods of improving string efficiency	**12**

	Corona – Critical disruptive voltage - Visual Critical Voltage – corona loss - Factors affecting corona, advantages and disadvantages, methods of reducing corona Sag – calculation **Electrical design of transmission line** Constants of transmission line – Resistance, inductance and capacitance Inductance and capacitance of a single-phase transmission line Inductance and capacitance of a three-phase transmission line with symmetrical and unsymmetrical spacing – transposition of lines	
4	**Distribution system** Types of distribution systems Types of DC distributors – calculations – distributor fed at one end and at both ends Types of AC distributors – calculations **Smart Grid** – Introduction - challenges and benefits – architecture of smart grid introduction to IEC 61850 and smart substation	**10**

Course Assessment Method
(CIA: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Internal Examination- 3 (Written)	Total
5	15	5	10	5	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, Each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

CO	Course Outcome	Bloom's Knowledge Level (KL)	Assessment Tool
CO1	Illustrate various conventional sources of energy generation.	**K2**	Written Exam and Assignment
CO2	Analyse the economics of power generation and power factor improvement.	**K3**	Written Exam and Assignment
CO3	Design mechanical and electrical parameters of a transmission system.	**K3**	Written Exam and Assignment
CO4	Classify different types of AC and DC distribution systems.	**K2**	Written Exam and Assignment

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	-	-	-	-	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Power System Engineering	D. P. Kothari and I. Nagrath	Tata McGraw Hill	3rd edition, 2011
2	Electrical Power System	Wadhwa	New Age International Publishers	7th edition, 2017

Reference Books				
Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A text book of Power system Engineering	A. Chakrabarti, M.L. Soni, P.V. Gupta, V.S. Bhatnagar	Dhanpat Rai	9th edition, 2008
2	Power System Analysis	John J. Grainger, William D. Stevenson	McGraw Hill	2nd edition, 2016
3	Smart Grids, Infrastructure, Technology and Solutions	A Stuart Borlase	CRC Press	7th edition, 2017
4	Power Generation, Operation, and Control	Allen J. Wood, Bruce F. Wollenberg, and Gerald B. Sheblé	Wiley	3rd Edition, 2013
5	Electric Power Distribution Engineering	Turan Gonen	CRC Press	4th Edition, 2020

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/105/108105104/
2	https://nptel.ac.in/courses/108/105/108105067/

SEMESTER S4

ENERGY SYSTEMS

Course Code	**MNEET409**	**CIE Marks**	**40**
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**ESE Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST104 Introduction to Electrical & Electronics Engineering/ GCEST204 - Basic Electrical and Electronics Engineering MNEET309 Introduction to Power Engineering	**Course Type**	Theory

Course Objectives:

1. To introduce various types of renewable energy sources.
2. To discuss various means of generating and storing energy.
3. To highlight the importance of renewable energy.
4. To introduce various energy standards and means to improve efficiency of systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Energy Scenario:** Indian Energy Scenario, World Energy Scenario, Indian Energy Sector Reforms, Energy and Environment, Energy Security, Energy conservation act **Energy Efficient Systems:** Reducing pollution and improving efficiency in buildings, Green Building Standards, Types of lamps and their efficiencies **Energy Standards:** International Energy Standards-ISO50001, Bureau of Energy Efficiency, star rating	**10**
2	**Renewable Energy Resources:** Solar Thermal System-Working Principle, Block diagram, Solar Photovoltaic System- Working Principle-Block diagram, Solar cell efficiency calculation, Wind Energy Systems- Working Principle-Block diagram, wind power equation, Energy from Waves and tides- Working Principle-Block diagram, Ocean Thermal Energy System- Working Principle-Block diagram, Energy from Biomass	**10**
3	**Energy Storage:** Importance of Energy Storage- Means of Storing Energy- Principle of operation and performance comparison. Compressed air storage, Fly wheel Energy Storage, Battery Storage **Battery:** Specification, Charging/Discharging rate, Primary and secondary cells- Dry cell, lead acid, lithium ion, Lithium air, Nickel Cadmium, Nickel Metal Hydride **Fuel Cell:** Working Principle, efficiency	**10**
4	**Energy Management:** Significance and general principles of Energy Management, Energy audit-types and procedure, Energy audit report, Instruments for energy auditing **Energy Economics:** Traditional Types of Rates - Single-Part Rates - Two-Part Rates - Three-Part Rates – Numerical problems	**12**

	Energy demand forecasting: Introduction –Forecasting using simple indicators- trend analysis- end use method **Economic Analysis of Energy Investments** - calculation of energy efficiency and payback period - Characteristics of Energy Projects - Identification of Costs and Benefits - Valuation of Costs and Benefits - Indicators of Cost-Benefit Comparison Without Time Value - Net Present Value Based Indicators - Role of Discount Rates - Internal Rate of Return – Numerical Problems	

Suggestions on Project Topics:

- Energy Conservation Action Plan
- Smart City Energy Planning
- Solar PV System Design
- Hybrid Renewable Energy System
- Solar Water Heating Optimization
- Battery Management System Design
- Compressed Air Energy Storage
- Energy Audit & Management
- Carbon Footprint Assessment
- Waste-to-Energy System

Course Assessment Method
(CIA: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Internal Examination- 3 (Written)	Total
5	15	5	10	5	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, Each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

CO	Course Outcome	Bloom's Knowledge Level (KL)	Assessment Tool
CO1	Illustrate Indian and global energy scenarios, and identify major international and Indian standards for Energy Management.	**K3**	Written Exam and Project
CO2	Elaborate the different conventional and non-conventional energy generation schemes.	**K3**	Written Exam and Project
CO3	Analyze the principles of operation and compare performance of various energy storage technologies.	**K3**	Written Exam and Project
CO4	Apply energy management principles through auditing procedures and evaluate energy economics.	**K3**	Written Exam and Project

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	-	-	-	-	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Guide to Energy Management	Barney L. Capehart, Wayne C. Turner and William J. Kennedy	The Fairmont Press Inc.	9th Edition, 2021
2	Energy Storage for Power Systems	A.G.Ter-Gazarian	The Institution of Engineering and Technology (IET) Publication, UK	3rd Edition, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**

1	Renewable Energy Sources and Emerging Technology	K.C. Kothari, D. P. Ranjan, Rakesh Singal	PHI	3rd Edition, 2022
2	Energy Resources: Conventional & non-conventional	M.V.R. Koteswara Rao	BS Publications/BSP Books	2nd Edition, 2020
3	Efficient Lighting Applications & Case Studies	Albert Thumann, Scott Dunning	The Fairmont Press, Inc.	2nd Edition, 2019
4	Energy Efficiency in Electrical Utilities	Bureau of Energy Efficiency	Guide book for National Certificate Examination for Energy Managers and Energy Auditors	2021 Edition
5	Energy Economics- Concepts, Issues, Markets and Governance	Subhes C. Bhattacharyya	Springer	3rd Edition, 2023

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://nptel.ac.in/courses/108105058
2	https://nptel.ac.in/courses/115105127
3	https://nptel.ac.in/courses/103107157

SEMESTER S5

ELECTRICAL MACHINES

Course Code	MNEET509	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	ESE Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST104 Introduction to Electrical & Electronics Engineering/ GCEST204 - Basic Electrical and Electronics Engineering	Course Type	Theory

Course Objectives:

1. To provide exposure to the concepts of electrical machines including constructional details, principle of operation and performance analysis.
2. To familiarize students with the appropriate electrical machines required for different applications.
3. To enable students to evaluate performance of transformers and motors based on test results.
4. To introduce the performance characteristics of various types of electrical machines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**DC Machines and Transformers** DC Machines-principle of operation of DC generator - emf equation - types of excitations - separately excited, shunt and series excited DC generators, compound generators. General idea of armature reaction, Open circuit and load characteristics-simple numerical problems. Principles of dc motors-torque and speed equations-torque speed characteristics- Characteristics and applications of dc shunt, series and compound motors. Methods of starting, losses and efficiency - simple numerical problems. Transformers –principle of operation –emf equation - phasor diagram - losses and efficiency –OC and SC tests-efficiency calculations - maximum efficiency –all day efficiency – simple numerical problems.	12
2	**Synchronous machines** Parts of synchronous generator – principle of operation–types –emf equation of alternator – regulation of alternator under lagging and leading power factor – determination of regulation by emf method – numerical examples. Principle of operation of synchronous motors - methods of starting - V curves - synchronous condenser.	10
3	**Three phase induction motors** Slip ring and squirrel cage types-principle of operation–rotating magnetic field–equivalent circuit, torque slip characteristics-no load and blocked rotor tests. Methods of starting –direct online, star delta, rotor resistance and auto transformer starting.	10

	Induction generator- principle of operation – self excited induction generators.	
4	**Single phase motors and Special machines** Principle of operation of single-phase induction motor –split phase motor – capacitor start motor. Stepper motor – principle of operation – types. Principle of operation and applications of universal motor and servomotor (dc and ac). Permanent magnet motors– principle of operation of PMSM and PMBLDC motor, applications.	**10**

Course Assessment Method

(CIA: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Internal Examination- 3 (Written)	Total
5	15	5	10	5	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, Each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

CO	Course Outcome	Bloom's Knowledge Level (KL)	Assessment Tool
CO1	Understand the performance of DC machines and single-phase transformers.	**K3**	Written Exam and Assignment
CO2	Evaluate the performance characteristics of synchronous machines.	**K3**	Written Exam and Assignment
CO3	Analyze the performance characteristics of three-phase induction motors for industrial applications.	**K3**	Written Exam and Assignment

CO4	Understand the working principles and applications of single-phase motors and special machines for household and industrial use.	**K2**	Written Exam and Assignment

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electrical Machinery	P.S. Bimbra	Khanna Publishers	8th Edition, 2023
2	Theory of AC Machines	J. Nagrath and D.P. Kothari	Tata McGraw Hill	5th Edition, 2022

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electric Machinery	A.E. Fitzgerald, C. Kingsley and S. Umans	McGraw Hill	7th Edition, 2019
2	Theory of Alternating Current Machinery	M.N. Langsdorf	Tata McGraw Hill	3rd Edition, 2020
3	The Performance and Design of AC Machines	M.G. Say	CBS Publishers	5th Edition, 2021
4	Electric Machines: Analysis and Design Applying MATLAB	J. Cathey	McGraw Hill	2nd Edition, 2022
5	Principles of Electric Machines and Power Electronics	P.C. Sen	John Wiley & Sons	4th Edition, 2023

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/102/108102146/
2	https://archive.nptel.ac.in/courses/108/105/108105017/
3	https://archive.nptel.ac.in/courses/108/105/108105131/
4	https://archive.nptel.ac.in/courses/108/105/108105155/

SEMESTER S6

SOLAR AND WIND ENERGY CONVERSION SYSTEMS

Course Code	**MNEET609**	**CIE Marks**	**40**
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**ESE Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	MNEET309 INTRODUCTION TO POWER ENGINEERING, MNEET409 ENERGY SYSTEMS	**Course Type**	Theory

Course Objectives:

1. To introduce the fundamentals of solar energy conversion systems.
2. To learn the design techniques of standalone and grid-connected PV systems.
3. To understand the working of wind energy conversion systems.
4. To study the integration of solar and wind power systems with the grid.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Solar Energy:** Introduction - Basic Concept of Energy -Source of Solar Energy - Formation of the Atmosphere - Solar Spectrum. Solar Constant -Air Mass -Solar Time-Sun Earth Angles- Solar Radiation-Instruments to Measure Solar Radiation-Pyrheliometer –Pyranometer - Sunshine Recorder -Solar Radiation on a Horizontal Surface - Extraterrestrial Region-Terrestrial Region -Solar Radiation on an Inclined Surface -Conversion Factors -Total Solar Radiation on an Inclined/Tilted Surface - Monthly Average Daily Solar Radiation on Inclined Surfaces. **Solar Thermal System:** Principle of Conversion of Solar Radiation into Heat, – Solar thermal collectors –General description and characteristics –Flat plate collectors –Heat transfer processes –Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) – performance evaluation. Applications -Solar heating system, Air conditioning and Refrigeration system, Pumping system, solar cooker, Solar Furnace, Solar Greenhouse, solar water heater	**12**
2	**Solar PV Systems:** Introduction - Fundamentals of Semiconductor and Solar Cells - Photovoltaic Effect - Solar Cell (Photovoltaic) Materials - Basic Parameters of the Solar Cell - Generation of Solar Cell (Photovoltaic) Materials - Photovoltaic (PV) Module and PV Array - Single-Crystal Solar Cell Module, Thin-Film PV Modules, III-V Single Junction and Multijunction PV Modules - Emerging and New PV Systems - Packing Factor of the PV Module - Efficiency of the PV Module - Energy Balance Equations for PV Modules - Series and Parallel Combination of PV Modules - Effect of shadowing - Maximum Power Point Tracker (MPPT) using buck-boost converter. Solar PV Systems - stand-alone and grid connected - Design steps for a Stand-Alone system - Storage batteries and Ultra capacitors.	**10**

3	**Wind Energy:** Wind Turbines - Introduction - Origin of Winds - Nature of Winds - Classification of Wind Turbines - Wind Turbine Aerodynamics - Basic principles of wind energy extraction - Extraction of wind turbine power (Numerical problems) - Weibull distribution - Wind power generation curve - Betz's Law - Modes of wind power generation.	**10**
4	**Wind Energy Conversion Systems:** Introduction - Components of WECS - Fixed speed drive scheme - Variable speed drive scheme - Wind-Diesel Hybrid System - Induction generators - Doubly Fed Induction Generator (DFIG) - Squirrel Cage Induction Generator (SCIG) - Power converters in renewable energy system - AC-DC Converters, DC-DC Converters, DC-AC Converters (Block Diagram Only) - Effects of Wind Speed and Grid Condition (System Integration) - Environmental Aspects - Wind Energy Program in India	**10**

Course Assessment Method

(CIA: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Internal Examination- 3 (Written)	Total
5	15	5	10	5	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, Each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

CO	Course Outcome	Bloom's Knowledge Level (KL)	Assessment Tool
CO1	Explain the fundamentals of solar energy and solar thermal conversion systems.	**K2**	Written Exam and Assignment
CO2	Design standalone and grid-connected PV systems.	**K3**	Written Exam and Assignment
CO3	Describe different wind energy conversion systems and their principles.	**K2**	Written Exam and Assignment
CO4	Evaluate the performance and integration aspects of wind power generation systems.	**K2**	Written Exam and Assignment

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	-	-	-	-	-	-	-	-	2
CO2	3	3	1	-	-	-	-	-	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Reference Books				
Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Renewable Energy Systems	Thomas E. Kissell, David M. Buchla, Thomas L. Floyd	Pearson	1st Edition, 2014
2	Handbook of Solar Energy: Theory, Analysis and Applications	G. N. Tiwari, Arvind Tiwari, Shyam	Springer	2nd Edition, 2023
3	Wind Energy Systems and Applications	D. P. Kothari, S. Umashankar	Narosa Publishers	2nd Edition, 2022
4	Solar Energy Engineering	A.A.M. Saigh (Ed)	Academic Press	3rd Edition, 2022
5	Solar Energy: Fundamentals, Design, Modelling and Applications	G.N. Tiwari	Narosa Publishers	4th Edition, 2021
6	Solar Energy Thermal Processes	J.A. Duffie and W.A. Beckman	J. Wiley	5th Edition, 2023

7	Wind Energy- Theory and Practice	Siraj Ahmed	Prentice Hall of India	3rd Edition, 2022
8	Non-Conventional Energy Resources	Khan B. H.	Tata McGraw Hill	3rd Edition, 2022
9	Renewable Energy Sources and Emerging Technologies	D.P. Kothari, K.C. Singal, Rakesh Ranjan	Prentice Hall of India	3rd Edition, 2021
10	Energy Technology	Rao S. and B. B. Parulekar	Khanna Publishers	3rd Edition, 2022
11	Renewable and Novel Energy Sources	Sab S. L.	MI Publications	2nd Edition, 2020
12	Non-Conventional Energy Resources	Sawhney G. S.	PHI Learning	3rd Edition, 2022
13	Renewable Energy Sources and Their Environmental Impact	Abbasi S. A. and N. Abbasi	Prentice Hall of India	2nd Edition, 2021
14	Renewable Energy - Power for Sustainable Future	Boyle G. (ed.)	Oxford University Press	5th Edition, 2023
15	Wind Power Plants and Project Development	Earnest J. and T. Wizelius	PHI Learning	2nd Edition, 2020
16	Principles of Solar Engineering	F. Kreith and J.F. Kreider	McGraw Hill	3rd Edition, 2021
17	Renewable Energy – Sources for Fuel and Electricity	Johansson T. B., H. Kelly, A. K. N. Reddy and R. H. Williams	Earth scan Publications	2nd Edition, 2022

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://archive.nptel.ac.in/courses/115/107/115107116/
2	https://archive.nptel.ac.in/courses/115/103/115103123/
3	https://nptel.ac.in/courses/101104546
4	https://archive.nptel.ac.in/courses/117/108/117108141/
5	https://archive.nptel.ac.in/courses/108/105/108105058/
6	http://digimat.in/nptel/courses/video/115105127/L02.html
7	https://archive.nptel.ac.in/courses/103/103/103103206/