West Bengal State Council of Technical & Vocational Education and Skill Development
(Technical Education Division)

Syllabus
of

Diploma in Electrical Engineering [EE]

Part-II (4th Semester)

Revised 2022

4th Semester

Sl.No	Category of course	Code No	Course Title	Credits	Marks	Contact Hours per Week	
						L	P
1	Program Core Course	**EEPC202**	Power Electronics Converters and Application	3	100	3	0
2	Program Core Course	**EEPC204**	Power Electronics Converters and Application Laboratory	1	100	0	2
3	Program Core Course	**EEPC206**	Electric Power Transmission and Distribution	3	100	3	0
4	Program Core Course	**EEPC208**	Electric Power Transmission and Distribution Laboratory	1	100	0	2
5	Program Core Course	**EEPC210**	Induction, Synchronous and Special Electrical Machines	3	100	3	0
6	Program Core Course	**EEPC212**	Induction, Synchronous and Special Electrical Machines Laboratory	1	100	0	2
7	Program Core Course	**EEPC214**	Renewable Energy Power Plants	3	100	3	0
8	Program Core Course	**EEPC216**	Renewable Energy Power Plants Laboratory	1	100	0	2
9	Program Elective course I	**EEPE 202**	Switchgear and protection	3	100	3	0
10	Program Elective course I Lab	**EEPE204**	Switchgear and Protection Laboratory	1	100	0	2
11	Project	**PR202**	Minor Project	1	100	0	2
TOTAL				**21**	**1100**	**15**	**12**
Total contact hrs./ week =27							

- Student **contact hrs./ week =27**
- Theory and practical periods of 60 minutes each
- Abbreviation: L: Lecture class; P: Practical class
- **For Theoretical subjects**: Internal Assessment (40 Marks): Mid semester class test: 20 Marks; Quizzes, viva-voce, Assignment: 10 Marks; Attendance: 10; External Assessment: 60 Marks.
- **For Practical/ Sessional Subjects**: Internal Assessment-60 Marks [Continuous Evaluation:50; Class Attendance:10]; End Semester Assessment-40 Marks [Assignment on the day of Viva-voce and Practical Report submission:20; Viva-voce:20]
- To make the students more familiar with software, effort should be made to prepare laboratory report (like graph; data table etc.) in soft format in addition with traditional hard copy wherever possible.

Course Code	:	EEPC202
Course Title	:	Power Electronics Converters and Applications
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course Objective

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Maintain the proper functioning of power electronic devices.

Course Contents:

Contents (Theory):		Hrs./Unit
Unit : 1	**1. Power semiconductor devices** **1.1 THYRISTOR (SCR)** 1.1.1 Construction, symbol, operation & two transistor analogy. 1.1.2 V-I characteristics of SCR (Holding current, Latching current, Break over voltage). 1.1.3 Thyristor specifications – voltage rating, current rating, power rating, dv/dt, di/dt, Gate current, temperature. 1.1.4. Utility of Snubber circuit, Freewheeling diode. 1.1.5. SCR mounting and cooling. 1.1.6 DIAC, TRIAC, SCS – Principle of operation, specification, characteristics & application. 1.1.7 IGBT - Principle of operation, specification, characteristics & application. 1.1.8 Review of Power BJT, Power MOSFET, IGBT and GTO. 1.1.9. Comparison among Thyristor, BJT, MOSFET, IGBT and GTO as switch. 1.1.10. Concept of single electron transistor (SET) - aspects of Nano- technology.	**10**
Unit : 2	**2. Turn-on and Turn-off Methods of Thyristors** 2.1 SCR Turn-On methods: High Voltage, Thermal triggering, Illumination triggering, dv/dt triggering, Gate triggering. 2.2 Gate trigger circuits – Resistance and Resistance-Capacitance circuits. 2.3 SCR triggering using UJT, PUT: Relaxation Oscillator and Synchronized UJT circuit. 2.4 Pulse transformer and opto-coupler based triggering. 2.5 SCR Turn-Off methods: Class A- Series resonant commutation circuit, Class B-Shunt-Resonant commutation circuit, Class C-Complimentary Symmetry commutation circuit, Class D –Auxiliary commutation, Class E- External pulse commutation, Class F- Line or natural commutation.	**10**
Unit: 3	**3.Converter and Inverter** **3.1. AC to DC Converter:** 3.1.1 Single phase fully controlled Half Wave Converter with a) Resistive load b) R-L load, 3.1.2 Single phase fully controlled Full Wave Converter a) Resistive load b) R-L load, 3.1.3 Three phase fully controlled Bridge Converter a) with Resistive load b) with RL load.	**12**

	3.2 Cycloconverter – Principle of operation of Single phase & Three phase cycloconverter, Basic circuit diagram, Input & Output waveforms, applications. **3.3 Inverter:** 3.3.1 Classification of Single phase & Three phase Inverter – Line commutated & Forced commutated Inverters, Series, Parallel, Bridge Inverter 3.3.2 Operation of basic Series Inverter. 3.3.3 Operation of basic Parallel Inverter. 3.3.4 Operation of Single-phase Bridge Inverter - a) Half Bridge Inverter b) Full Bridge Inverter 3.3.5 Pulse Width Modulated Inverter – a) Single pulse width Modulated Inverter. b) Multiple pulse width Modulated Inverter. **c)** Sinusoidal pulse width Modulated Inverter.	
Unit: 4	**4. DC Chopper:** 4.1Principles of chopper. 4.2 Classification – a) Step-up & Step-down chopper b) Second quadrant, Two quadrant & Four quadrant operation. 4.3 Type-A, B, C, D & E chopper – Operating Principle and applications. 4.4 Jones chopper. 4.5 Related numerical problems.	**04**
Unit: 5	**5.DC & AC Drives:** 5.1Speed control of separately excited DC motor by single phase fully controlled converter. 5.2 Speed control of separately excited DC motor with three phase fully controlled converter. 5.3Speed control of DC series motor with chopper control. 5.4 Speed control of Three phase Induction motor with variable frequency PWM VSI. 5.5 Speed control of Three phase Induction motor with variable voltage variable frequency control.	**06**
Unit 6	**6. Power Supply** 6.1 Uninterrupted power supply – Principle of operation & Block diagram of On load & Off load type UPS. 6.2 SMPS- Principle of operation and application of Forward converter and Flyback converter.	**03**
	Total	**45**

References:

1. Soumitra Kumar Mandal, Power Electronics McGraw Hill Education (India) Private Limited, ISBN-13:978-93-3290-114-8

2. Ramamoorty M., An Introduction to Thyristors and their applications, East-West Press Pvt. Ltd., New Delhi, ISBN: 8185336679.

3. Sugandhi, Rajendra Kumar and Sugandhi, Krishna Kumar, Thyristors: Theory and Applications, New Age International (P) ltd. Publishers, New Delhi, ISBN: 978-0-85226-852-0.

4.Bhattacharya, S.K., Fundamentals of Power Electronics, Vikas Publishing House Pvt. Ltd. Noida. ISBN: 978-8125918530.

5.Jain & Alok, Power Electronics and its Applications, Penram International Publishing (India) Pvt. Ltd, Mumbai, ISBN: 978-8187972228.

6. Rashid,Muhammad, Power Electronics Circuits Devices and Applications, Pearson Education India, Noida, ISBN: 978-0133125900.

7. Singh, M. D. and Khanchandani, K.B., Power Electronics, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2008 ISBN: 9780070583894.

8. Zbar, Paul B., Industrial Electronics: A Text –Lab Manual, McGraw Hill Publishing Co. Ltd., New Delhi, ISBN: 978-0070728226.

9. Grafham D.R., SCR Manual, General Electric Co., ISBN: 978-0137967711.

10.Agrawal; Power Electronic Systems: Theory & Desig; Pearson

11. Bimal K. Bose; Modern Power Electronics and AC Drives; Pearson

12. Asghar, Power Electronics; PHI Learning

Course Outcomes

The theory andrelevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

a) Select power electronic devices for specific applications.

b) Know turn-on and turn-off circuits of Thyristors.

c) Understand the switching circuits and their applications.

d) Understand working and performance characteristics of phase-controlled rectifiers, cycloconverter and inverters.

e) Understand working and performance characteristics of chopper.

f) Apply different types of converters for industrial applications.

g) Understand the basic operation of different power supply.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva voce, Assignment: 10 Marks	Attendance : 10 marks

External Assessment (End Semester Examination:60 Marks)	
GROUP	**UNIT**
A	1,2
B	3,4
C	5,6

Course Code	:	EEPC204
Course Title	:	Power Electronics Converters and Applications LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course Objective

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Maintain the proper functioning of power electronic devices.

Practicals (at least EIGHT are to be performed)

1. Test the proper functioning of power electronic switches – SCR, IGBT, SCS and TRIAC.
2. Test the proper functioning of DIAC to determine the break over voltage.
3. Determine the latching current and holding current using V-I characteristics of SCR.
4. Test the variation of R, C in R and RC triggering circuits on firing angle of SCR.
5. Test the effect of variation of R, C in UJT triggering technique.
6. Perform the operation of Class – A, B, C turn off circuits.
7. Perform the operation of Class –D, E, F turn off circuits.
8. Use CRO to observe the output waveform of half wave-controlled rectifier with resistive load and determine the load voltage.
9. Use CRO to observe the output waveform of Full wave-controlled rectifier with R load, RL load, free wheeling diode and determine the load voltage.
10. Determine the firing angle using DIAC and TRIAC phase-controlled circuit on output power under different loads such as lamp, motor or heater
11. Simulate above firing angle control on SCILAB software
12. Perform speed control of DC series / DC separately excited motor using SCR.
13. Perform speed control of 3-phase Induction motor using PWM inverter. Interpret speed-torque characteristics. Use variable voltage variable frequency drive.
14. Test the performance of given UPS.
15. Study on SMPS.

Course outcomes:

The practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

a) Perform the testing of power electronic devices for specific applications.
b) Apply different turn-on and turn-off circuits of Thyristors.
c) Maintain phase-controlled rectifiers.
d) Apply converters for industrial control circuits.
e) Understanding of performance of different power supply.

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. **Continuous Internal Assessment of 60 marks** is to be carried out by the teachers throughout the fourth Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks
2. **External Assessment (end Semester examination) of 40 marks** shall be held at the end of the fourth Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Course Code	:	EEPC206
Course Title	:	ELECTRIC POWER TRANSMISSION AND DISTRIBUTION
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course Objective

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences –

- Maintain the proper functioning of the electrical transmission and distribution systems.

Contents (Theory):		Hrs./Unit
Unit : 1	Basics of Transmission and Distribution 1.1. Single line diagrams with components of the electric supply transmission and distribution systems. 1.2. Classification of transmission and distribution lines: Primary and secondary transmission; Primary and secondary distribution; standard voltage level used in India. 1.3. Classification of transmission lines: based on type of voltage, voltage level, length and others Characteristics of high voltage for power transmission. 1.4. Kelvin's laws for the economic choice of conductor size – related problem	**07**
Unit : 2	Transmission Line Parameters and Performance 2.1 Line Parameters: Concepts of R, L and C of line parameters and types of lines. Performance of short line: Efficiency, regulation and its derivation, effect of power factor Ferranti Effect (Related Numerical Problems). 2.2 Performance of medium line: representation, nominal 'T', nominal 'π' and end condenser methods (Related Numerical Problems). 2.3 Representation of long transmission line. 2.3.1. Surge impedance. 2.4 Transposition of conductors and its necessity. 2.5 Skin effect and proximity effect.	**08**
Unit: 3	Extra High Voltage Transmission 3.1 Extra High Voltage AC (EHVAC) transmission line: Necessity, advantages, limitations and applications and lines in India. Corona effect. 3.2 High Voltage DC (HVDC) Transmission Line: Necessity, components, advantages, limitations and applications. Layout of monopolar, bi-Polar and homo-polar transmission lines. HVDC lines in India. 3.3 Features of EHVAC and HVDC transmission line. 3.4 Flexible AC Transmission line: Features, Types of FACTS controller. 3.5 New trends in wireless transmission of electrical power.	**08**

Unit: 4	A.C Distribution System 4.1 AC distribution: Components, classification, requirements of an ideal distribution system. 4.2 Feeder and distributor, factors to be considered in design of feeder and distributor. 4.3 Types of different distribution schemes: radial, ring, and grid, layout, advantages, disadvantages and applications. 4.4 Voltage drop, sending end and receiving end voltage (Related Numerical Problems). 4.5 Methods of solving A.C.-1 phase & 3 phase -phase connection (balanced) distribution system. (Numerical based on 1-ph & 3-ph balanced distribution system) 4.6 Distribution Sub-Station: Classification, site selection, advantages, disadvantages and applications. 4.7 Single Line diagram (layout) of 33/11KV Sub-Station, 11KV/400V sub-station, Main connection schemes, Symbols and functions of their components.	**10**
Unit: 5	Components of Transmission and Distribution Line 5.1 Overhead Conductors: Properties of material, types of conductors with trade names, Sag in Overhead Lines, Calculation of Sag (Related Numerical Problems), Stringing chart and its uses, Spacing of conductors, length of span, Relevant I.E. Rules. 5.2 Line supports: Requirements, types of line structures and their specifications, methods of erection. 5.3 Line Insulators: Properties of insulating material, selection of material, types of insulators and their applications, failure of insulators, causes of insulator failure, creepage distance (definition & significance only), derivation of equation of string efficiency for string of three suspension insulator, methods of improving string efficiency. 5.4 Underground Cables: Requirements, classification, construction, Description of (i) PVC, (ii) PILC (iii) FRLS (Fire Retardant Low Smoke), (iv) XLPE cables & (v) Gas filled (SF6) cables, comparison with overhead lines, cable laying. 5.5 Power Factor Improvement Using Static condenser, and Synchronous condenser (Related Numerical Problems), static VAR compensator.	**12**
	Total	**45**

References:

1. Mehta, V.K., Principles of Power System, S. Chand and Co. New Delhi, ISBN: 9788121924962
2. Theraja, B.L.; Theraja, A.K., A Textbook of Electrical Technology Vol. III, S.Chand and Co. New Delhi, ISBN : 9788121924900
3. Gupta, A Course in Power Systems, S.K. Kataria and sons, New Delhi, ISBN: 9788188458523
4. Uppal,S.L., A Course in Electrical Power, S.K.Khanna Publisher New Delhi, ISBN : 978817409238
5. Soni;Gupta; Bhatnagar, A Course in Electrical Power, Dhanpat Rai and Sons New Delhi, ISBN: 9788177000207
6. Ingole; Power Transmission and Distribution, 1e; Pearson
7. Sivanagaraju; Electric Power Transmission and Distribution; Pearson.
8. Singh; Electric Power Generation, Transmission and Distribution; 2nd Edition; PHI Learning.

Course Outcomes

The theory and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

a) Draw and explain single line diagrams of transmission and distribution systems.
b) List and identify transmission line parameters and calculate its performance.
c) Compare and explain the EHVAC and HVDC transmission systems.
d) Explain distribution systems with distribution substation.
e) List and explain different components of transmission and distribution Line.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva voce, Assignment: 10 Marks	Attendance: 10 marks
External Assessment (End Semester Examination:60 Marks)		

GROUP	**UNIT**
A	1,2
B	3,4
C	5

Course Code	:	EEPC 208
Course Title	:	ELECTRIC POWER TRANSMISSION AND DISTRIBUTION LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course Objective

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

• Maintain the proper functioning of the electrical transmission and distribution systems.

Practicals

1,2,3,4 compulsory and any three from rest	
1.	Students should conduct following activities (any two) Activity-I: Prepare a report based on transmission line network in West Bengal. Activity-II: Collect the information on components of transmission line. Activity-III: Evaluate transmission line performance parameters of a given line. Activity-IV: Library/ Internet survey of electrical high voltage line and HVDC lines. Activity-V: Visit to Transmission/ Distribution Substation and make a report on the visit.
2.	Prepare a model showing: (any two) Activity-I: Single line diagram of electric supply system.

	Activity-II: Single line diagram of a given distribution system. Activity-III: Short line and medium transmission line. Activity-IV: Write a report on the same by giving the details of lines in West Bengal.
3.	Prepare a power point presentation: (any two) Activity-I: Extra High Voltage AC Transmission line. Activity-II: High Voltage DC Transmission line. Activity-III: Flexible AC Transmission line. Activity-IV: New trends in wireless transmission of electrical power.
4.	Collect information on: Activity: A.C Distribution System adjacent to your institute.
5.	Study samples of Overhead Conductors, Underground Cables, Line supports and Line Insulators.
6.	Demonstrate various system faults by D.C. network analyzer.
7.	Demonstrate the improvement of p.f. using static condenser.
8.	Study of distribution simulator using power transmission trainer.

Course Outcomes

The theory, practical experiences and relevant soft skills associated with the course are to be taught and implementatecd so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret the normal operation of the electric transmission and distribution systems.

b) Demonstrate the functioning of the medium and high voltage transmission system.

c) Identify the components of the extra high voltage transmission system.

d) Illustrate the functioning of the low voltage AC distribution system.

e) Demonstrate the components of the transmission and distribution lines.

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. Continuous Internal Assessment of 60 marks is to be carried out by the teachers throughout the fourth Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks

2. External Assessment (end Semester examination) of 40 marks shall be held at the end of the fourth Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Course Code	:	EEPC210
Course Title	:	INDUCTION, SYNCHRONOUS AND SPECIAL ELECTRICAL MACHINES
Number of Credits	:	3 (L: 3, T: 0, P:0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Maintain Induction, Synchronous and FHP Machines used in different applications.

Contents (Theory):		Hrs./Unit
Unit : 1	**Three Phase Induction Motor** 1.1 Working principle: production of rotating magnetic field, Synchronous speed, rotor speed and slip. 1.2 Constructional details of 3 phase induction motors: Squirrel cage induction motor and Slip ring induction motor. 1.3 Rotor quantities: frequency, induced emf, power factor at starting and running condition. (Numerical) 1.4 Characteristics of torque vs. slip (or speed), Torques: starting, full load and maximum with relations among them. (Numerical) Effect of change in rotor circuit resistance and supply voltage on Torque-Slip characteristics. 1.5 Induction motor as a generalized transformer with phasor diagram and equivalent circuit. Four quadrant operation. 1.6 Power flow diagram, Losses, Efficiency. (Numerical) 1.7 Starters: need and types; DOL, stator resistance, auto transformer, star delta, rotor resistance and soft starters. 1.8 Speed control methods: stator voltage, pole changing, rotor resistance and Variable Voltage Variable Frequency (VVVF) speed control. 1.9 Braking ; Plugging, Rheostatic, Regenerative Method 1.10 Cogging & Crawling (simple idea) and remadial measures. 1.11 Concept of double cage rotor & deep-bar rotor. 1.12 Motor selection for different applications as per the load torque – speed requirements. 1.13 Maintenance of three phase induction motor.	**11**
Unit : 2	**Single phase induction motors** 2.1 Double field revolving theory, principle of making these motors self-starting. 2.2 Construction and working: Resistance start induction run, capacitor start induction run, capacitor start capacitor run, shaded pole, repulsion type, series motor, universal motor, and hysteresis motor. 2.3 Torque-speed characteristics for all of the above motors. 2.4 Motor selection for different applications as per the load torque-speed requirements. 2.5 Maintenance of single phase induction motor.	**06**

Unit: 3	**Three phase Alternators** 3.1 Principle of working, moving and stationary armatures. Advantages of Stationary armature and Rotating field system. 3.2 Methods of excitation systems of 3-phase alternator by – (a) Static excitation (b)Brushless Excitation (c) DC Generator 3.3 Constructional details: parts and their functions, rotor constructions; salient & nonsalient 3.4 Windings: Single and Double layer, Concentrated and Distributed 3.5 E.M.F. equation of an Alternator by considering short pitch factor and distribution factor. (Numerical) 3.6 Alternator loading: Factors affecting the terminal voltage of alternator; Armature resistance and leakage reactance drops. Armature reaction at various power factors and synchronous impedance. Phasor Diagram at lagging, leading and unity power factor. Terminal Voltage vs Load Current characteristics at different power factor. 3.7 Voltage regulation: direct loading and synchronous impedance method. Open and Short Circuit Characteristics (Numerical) 3.8 Active & Reactive power equations in terms of power angle at steady state for non-salient pole alternator.Power vs. Load angle characteristics. 3.9 Losses, efficiency and condition for maximum efficiency. 3.10 Parallel operation of alternators : reasons, advantages and conditions.(Numerical) 3.11 Synchronisation, Methods of synchronisation by (a) three lamp methd (b) using Synchroscope 3.12 Load-frequency characteristics of alternators running in parallel and sharing a common load. (numerical) 3.13 Active Power and Reactive Power control (concept only) 3.14 Maintenance of alternators.	**15**
Unit: 4	**Synchronous Motors** 4.1 Principle of working /operation, significance of load angle. 4.2 Methods of Starting of Synchronous Motor. 4.3 Torques: starting torque, running torque, pull in torque, pull out torque. 4.4 Synchronous motor on load with constant excitation (numerical) 4.5 Effect of excitation at constant load (numerical). 4.6 V-Curves and Inverted V-Curves. 4.7 Hunting and Phase swinging. 4.8 Losses in synchronous motors and efficiency (no numerical) 4.9 Application of synchronous motors.	**08**
Unit: 5	**Fractional horse power (FHP) Motors** 5.1 Construction and working: Synchronous Reluctance Motor, Switched Reluctance Motor, BLDC, Permanent Magnet Synchronous Motors, stepper motors, AC and DC servomotors. 5.2 Torque speed characteristics of above motors. 5.3 Applications of above motors.	**05**
	Total	**45**

References:

1. P.S. Bimbhra, Electric Machines, Khanna Book Publishing Co., New Delhi (ISBN:9789386173294)

2. Mittle, V.N. and Mittle, Arvind., Basic Electrical Engineering, McGraw Hill Education New Delhi, ISBN :9780070593572

3. Kothari, D. P. and Nagrath, I. J., Electrical Machines, McGraw Hill Education. New Delhi, ISBN:97800706996704.

4. Bhattacharya, S. K., Electrical Machines, McGraw Hill Education, New Delhi, ISBN:97893329028555.

5. Theraja, B.L., Electrical Technology Vol-II (AC and DC machines), S. Chand and Co. Ltd., New Delhi, ISBN: 9788121924375 6.

6. Sen, S. K., Special Purpose Electrical Machines, Khanna Publishers, New Delhi, ISBN: 97881740915297.

7. Janardanan E. G, Special Electrical Machines, Prentice Hall India, New Delhi ISBN: 97881203488068.

8. Purkait Bandyopadhyay; Electrical Machines; Oxford University Press

9. Chakraborti & Debnath; Electrical Machines; McGraw Hill Education

10. Ashfaq Husain & Haroon Ashfaq, Electric Machines, Dhanpat Rai & Co., New Delhi ISBN: 978-81-7700-166-2

11. Ghosh; Electrical Machines; Pearson

Course Outcomes:

The theory and relevant soft skills associated with the course are to be taught and implementatecd so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

1. Understand the construction and working principle, explain the characteristics of three phase induction motor and select various types of three phase induction motor for different applications.
2. Understand the construction and working principle, explain the characteristics of different types of single-phase induction motor and select various types of single-phase induction motor for different applications.
3. Understand the construction and working principle, explain the characteristics of three phase alternator and their applications.
4. Understand the construction and working principle, explain the characteristics of three phase synchronous motor and their applications.
5. Understand the construction and working principle, explain the characteristics of different types of FHP motor and select various types of FHP motors in different applications.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva voce, Assignment: 10 Marks	Attendance : 10 marks

External Assessment (End Semester Examination:60 Marks)	
GROUP	**UNIT**
A	1,2
B	3
C	4,5

Course Code	:	EEPC212
Course Title	:	INDUCTION, SYNCHRONOUS AND SPECIAL ELECTRICAL MACHINES LABORATORY
Number of Credits	:	2 (L: 0, T: 0, P:2)
Prerequisites	:	NIL
Course Category	:	PC

Course Objective:
The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
Maintain Induction, Synchronous and FHP Machines used in different applications.

Practicals: (at least EIGHT are to be done)

1. Identify the different parts (along with function and materials) for the given single phase and three phase induction motor.
2. Perform the direct load test on the three phase squirrel cage induction motor and plot the i) efficiency versus output, ii) power factor versus output, iii) power factor versus motor current and iv) torque – slip/speed characteristics efficiency versus output, v) power factor versus output, vi) power factor versus motor current and vii) torque – slip/speed characteristics.
3. Conduct the No-load and Blocked-rotor tests on given 3-phase squirrel cage induction motor and determine the equivalent circuit parameters.
4. Control the speed of the given three phase squirrel cage induction motor using the applicable methods: i) auto-transformer, ii) VVVF.
5. Measure the open circuit voltage ratio of the three-phase slip ring induction motor and perform the speed control by insertion of resistance in rotor circuit for slip ring induction motor.
6. Conduct the direct load test to determine the efficiency and speed regulation for different loads on the given single phase induction motor; plot the efficiency and speed regulation curves with respect to the output power.
7. Perform the direct loading test on the given three phase alternator and determine the regulation and efficiency.
8. Determine the regulation and efficiency of the given three phase alternator from OC and SC tests (Synchronous impedance method)
9. Conduct the test on load or no load to plot the ‘V’ curves and inverted ‘V’ curves (at no-load) of 3-phase

synchronous motor.

10. Dismantling and reassembling of single phase motors used for ceiling fans, universal motor for mixer.
11. Control the speed and reverse the direction of stepper motor
12. Control the speed and reverse the direction of the AC servo motor
13. Control the speed and reverse the direction of the DC servo motor

Course outcomes:

The practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Verify the performances of three phase induction motor experimentally and maintain it used in different applications.
b) Verify the performances of single-phase induction motor experimentally and maintain it used in different applications.
c) Verify the performances of three phase alternator experimentally and maintain it used in different applications.
d) Verify the performances of three phase synchronous motor experimentally and maintain it used in different applications.
e) Maintain FHP motors used in different applications

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. **Continuous Internal Assessment of 60 marks** is to be carried out by the teachers throughout the fourth Semester.
   Distribution of marks: Continuous evaluation:50 Marks; Class Attendance: 10 Marks
2. **External Assessment (end Semester examination) of 40 marks** shall be held at the end of the fourth Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Course Code	:	EEPC214
Course Title	:	**Renewable Energy Power Plants**
Number of Credits	:	3 (L: 3, T: 0, P:0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives: The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
Maintain the efficient operation of various types of renewable energy power plants.

Course contents:

Contents (Theory):		Hrs/ Unit
Unit1	1.1. Classification of energy resources. 1.2. Significance of Non-conventional energy resources. 1.3 Salient features of non-conventional sources and their availability in India.	**2**
Unit2	**Solar Photovoltaic system and Solar Power Plants** 2.1. Basic concept of Solar Radiation Geometry – Latitude, Longitude, Declination, Surface azimuth angle, Solar azimuth angle, Slope of surface, Hour angle, Angle of incidence. 2.2. Solar Map of India: Beam, Diffuse & Global solar power radiation. 2.3 Radiation on inclined surface (Expression only). 2.3 Measurement of solar radiation using Pyranometer. 2.4 Types of Solar Collectors: Liquid Flat plate collectors; Parabolic Trough, Parabolic Dish, Fresnel Reflectors. (Brief description) 2.5. Solar Photovoltaic (PV) system: 2.5.1 Principles for Electron-Hole Pair generation by Photon absorption, Photo-electric effect, Photo-conductive effect and Photovoltaic effect. 2.5.2 Solar cell and its classification. 2.5.3 Working principle of photovoltaic cell. 2.5.4 Current-voltage (I-V) and power voltage (P- V) characteristics of photovoltaic cell, Maximum power point (MPP),dark current, Fill factor, Short circuit current (Isc), Open circuit voltage (Voc), Cell efficiency. 2.5.5 Concept of PV module, PV panel, PV array and its formation. 2.5.6 Classification of PV system – Centralized Solar PV System. Distributed Solar PV System (Brief concept only) 2.6. Solar Photovoltaic (PV) power plant: Components, Layout, Construction, Working principle, Applications. 2.7 Concentrated Solar Power (CSP) plants – Components, Layout, Construction, Working principle, Applications. 2.8 Rooftop solar PV power system.	**15**
Unit 3	**Wind Energy and Wind Power Plants** 3.1 Wind Map of India: Wind power density in watts per square meter. 3.2. Lift and drag principle; long path theory.	**14**

	3.3. Energy estimation of wind, power coefficient (Cp); lift coefficient (C_L), drag coefficient (C_D); tip speed ratio. 3.2. Types of wind turbines 3.2.1. Horizontal axis small wind turbine: direct drive type, geared type, components and working. 3.2.2. Vertical axis small wind turbine: direct drive type, geared type, components and working. 3.3. Wind energy conversion system (WECS): 3.3.1. Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG), Wound Rotor Induction Generator (WRIG). 3.3.2. Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG). 3.4 Geared type wind power plants: Components, Layout and Working principle. 3.5 Direct drive type wind power plants: Components, Layout and Working principle.	
Unit 4	**Micro-hydro Power Plants** 4.1 Energy conversion process of hydro power plant. 4.2 Classification of hydro power plant: High, medium and low head. 4.3 Layouts of micro-hydro power plants. 4.4 Construction and working of hydro turbines used in different types of hydro power plant: High head – Pelton turbine Medium head – Francis turbine Low head – Kaplan turbine. 4.5 Safe Practices for micro hydro power plants.	**6**
Unit 5	**Biomass-based Power Plants** 5.1 Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk, municipal waste 5.2 Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-diesel, gobar gas. 5.3 Layout & working of a Bio-chemical based (e.g. biogas) power plant. 5.4 Layout & working of a Thermo-chemical based (e.g. Municipal waste) power plant. 5.5 Layout & working of Agro-chemical based (e.g. bio-diesel) power plant.	**8**
	Total	**45**

References:

1. Deambi, Suneel: From Sunlight to Electricity: a practical handbook on solar photovoltaic application; TERI, New Delhi ISBN:9788179935736.
2. David M. Buchla, Thomas E. Kissell, Thomas L. Floyd - Renewable Energy Systems, Pearson Education New Delhi, ISBN: 9789332586826
3. Rachel, Sthuthi; Earnest, Joshua – Wind Power Technologies, PHI Learning, New Delhi, ISBN: 978-93-88028-49- 3; E-book 978-93-88028-50-9

4. Khoiyangbam, R S Navindu; Gupta and Sushil Kumar; Biogas Technology: Towards Sustainable Development; TERI, New Delhi; ISBN: 9788179934043
5. Gipe, Paul: Wind Energy Basics, Chelsea Green Publishing Co; ISBN: 978-1603580304
6. Wizelius, Tore &Earnest, Joshua -PHI Learning, New Delhi, ISBN: 978-8120351660
7. Kothari, D.P. et al: Renewable Energy Sources and Emerging Technologies, PHI Learning, New Delhi, ISBN: -978-81-203-4470-9
8. Bhadra, S.N., Kastha, D., Banerjee, S, Wind Electrical Systems installation; Oxford University Press, New Delhi, ISBN: 9780195670936.
9. O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi (ISBN: 978-9386173-683)
10. B H Khan, Non-Conventional Energy Resources; McGraw Hill Education PVT Ltd.
11. Shobh Nath Singh; Non-Conventional Energy Resources; Pearson

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

1. Classify non-conventional energy resources and their features.

2. Define the terms related to solar geometry and explain the working principle of solar PV and CS power plants.

3. Define the terms related to wind turbine and explain the working of wind power plants along with constant & variable speed generators used there.

4. Classify hydro power plants and hydro turbines used for the plant. Explain the energy conversion method in hydro power plant.

5. Explain the layout & working of different types of biomass-based power plants.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva-voce, Assignment: 10 Marks	Attendance: 10

External Assessment (End Semester Examination:60 Marks)	
GROUP	UNIT
A	1,2
B	3
C	4,5

Course Code	:	EEPC216
Course Title	:	**Renewable Energy Power Plants Laboratory**
Number of Credits	:	1 (L: 0, T: 0, P:2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

1. Identify the parts of various renewable energy power plants
2. Maintain the efficient operation of various renewable energy power plants.

Practicals: (at least EIGHT are to be done)

1. Perform experiment to measure solar radiation using Pyranometer on tilted surface at different angles of inclination and plot radiation vs. time characteristics for certain duration.
2. Perform experiment to plot I-V characteristics of photovoltaic cell module and find out the solar cell parameters (O.C. voltage, Short circuit current, Voltage-current-power at Maximum Power point, Fill factor, Efficiency).
3. Study different parts of a solar flat plate collector/ solar concentrating collector.
4. Perform experiment to measure thermal performance of a solar water heating system.
5. Perform experiment to measure thermal performance of a solar cooker with varying reflector.
6. Identify & study different components of solar street lighting system for AC supply.
7. Identify & study the specified components of a 1 KW Small Wind Turbine (SWT) system.
8. Identify & study the specified components of water turbine using cut section model.
9. Set up the solar PV plant to produce electricity.
10. Set up the wind power plant of with a Small Wind Turbine to produce electricity.
11. Set up the Biogas power plant to produce electricity.
12. Integrate electrical power from solar PV plant, wind power plant and biogas power plant and apply to Microgrid system.
13. Study on assembling and dismantling of CSP plant using parabolic trough / parabolic dish.
14. Study on assembling of vertical axis / horizontal axis small wind turbine to produce electric power.
15. Study on assembling of a micro hydro power plant.
16. Study on assembling of a small biogas plant to generate electric power.

Course outcomes:
The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

1. Identify different components of solar PV and CS power plant and construct solar PV and CS power plant.
2. Identify different components of wind power plant and construct a small wind power plant.
3. Identify different components of micro hydro power plant and construct micro hydro power plant.
4. Identify different components of biomass based power plant and construct a biogas plant.
5. Integrate the power from different sources of renewable energy power plant and supply through Microgrid system.

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. Continuous Internal Assessment of 60 marks is to be carried out by the teachers throughout the fourth Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks

2. External Assessment (end Semester examination) of 40 marks shall be held at the end of the fourth Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Course Code	:	EEPE202
Course Title	:	SWITCHGEAR AND PROTECTION
Semester		Four
Number of Credits	:	3 (L: 3, P: 0)
Prerequisites	:	NIL
Course Category	:	PE
Full Marks		100 [Internal :40 Marks+ External: 60 Marks]

Course Objective

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Maintain switchgear and protection schemes used in electrical power systems.

Contents (Theory):		Hrs./Unit
Unit : 1	**Fundamental:** 1.1Necessity & functions of protective system. 1.2 Normal & abnormal conditions. 1.3 Types of faults & their causes. 1.4 Symmetrical and Asymmetrical fault- concept of positive, negative and zero sequence. 1.5.1 Use of current limiting reactors & their arrangements. 1.5.2 Short circuit fault calculations in lines fed by generators through transformers 1.5.3 Short- circuit KVA calculations for symmetrical faults – Numerical problems.	**5**
Unit : 2	**Circuit interrupting devices:** 2.1 Basic fuse terminology: fuse element, rated current, fusing current, fusing factor, prospective current, cut-off current, arcing time, rupturing capacity, total operating time. Fuse Characteristics 2.1.1 HRC fuses – construction, types, working, characteristics, selection and applications 2.2 Isolators- vertical break, horizontal break & pantograph type 2.3 Arc formation process, methods of arc extinction (High resistance and Low resistance), Arc voltage, Recovery voltage, Re-striking voltage, RRRV. 2.4 Circuit breakers- Concept, Classification, Working principle, Construction, Specification & Applications of 2.4.1 E.H.V/H.V – Minimum oil circuit breakers (M.O.C.B.), Air Blast Circuit Breaker (A.B.C.B),Sulphur Hexafluoride circuit breaker (SF6). Vacuum circuit breaker. 2.4.2 L.V.- Air circuit breakers (ACB), miniature circuit breakers (M C B), Moulded case circuit breakers (M C C B) , Earth leakage circuit breaker (E L C B or R C CB), Comparison of fuse & MCCB 2.5 Selection of MCCB for motor. 2.6 Selection and rating of HT and LT circuit breakers – breaking capacity, making capacity, rated operating duty, rated voltage. 2.7 Elementary idea of Auto-reclosing. 2.8 Concept of Gas insulated switchgear.	**12**
Unit: 3	**Protective Relaying:** 3.1 Fundamental quality requirements: Selectivity, Speed, Sensitivity, Reliability, Simplicity, Economy. 3.2 CT & PT used in protection: rating of CT and PT; Accuracy Class of CT and their significance, PT; Requirements, Basic circuit diagram, working principle & application of	**12**

	CVT and CCVT. 3.3 Zones of protection, primary & back-up protection. 3.4 Operating principles and construction (in brief) of: Electromagnetic relays (Attracted armature type, Solenoid type, Watt-hour meter type) , thermal relays, 3.5 Block diagram and working of static relays and Microprocessor based relays 3.6 Over current relay--- Time-current characteristics of definite time, instantaneous, inverse time and IDMT Relays. Use of very inverse-type O/C relay and extremely inverse type O/C relay**.** Time-setting, current-setting, PSM – Numerical problems**.** 3.7 Directional Relay - Construction, Characteristics: Constant product characteristics, Polar characteristics, Concept of dead zone, 30^0, 60^0 and 90^0connection. 3.8 Distance Protection Relay: Area of applications, Impedance relays, Reactance relay, MHO relay: operating characteristics, effect of arc resistance on their characteristics. 3.9 Differential Relay: Introduction, Current differential protection for an internal fault – fed from single & both ends. Voltage balance differential protection – Schematic diagram & operation (in brief). Mention the position of operating coil and the restraining coil for both the cases.	
Unit: 4	**Equipment Protection:** 4.1 P**rotection of Alternators** – Types of faults; Percentage differential stator protection, brief idea of: - rotor protection due to loss of excitation, protection against rotor overheating because of unbalance in load, overspeed protection, protection against motoring and field suppression. 4.2 **Transformer protection** – Types of faults; Percentage biased differential protection – numerical problems, Buchholz Relay: Construction, Operation, merit and demerits, rate of rise of pressure relay, WTI and OTI; over-fluxing protection, O/C protection, Earth fault protection and restricted earth fault protection scheme. **4.3 Protection of Motor**: Abnormalities & faults. Short circuit protection, Overload protection, Single phase preventer. **4.4 Protection of Busbar & transmission line** 4.4.1 Bus bar protection: Differential and Fault bus protection. 4.4.2 Transmission line protection: Overcurrent protection (Time graded, current graded), Distance and Pilot wire protection.	**10**
Unit: 5	**Over voltage Protection:** 5.1 Causes of over voltages. 5.2 Lighting phenomena & over voltage due to lightning. 5.3 Protection of transmission line & substation from direct stroke. 5.4 Types of lightning arresters & surge absorbers & their Construction & principle of operation. 5.5 Protection against traveling waves. 5.6 Insulation co-ordination.	**6**
	Total	**45**

References:

1. Mehta V K; Rohit Mehta, Principles of Power System – S. Chand & Company Ltd., New Delhi.ISBN-13- 978-8121924962; ISBN:10- 9788121924962

2. Rao. Sunil S., Switchgear and Protection, Khanna Publishers, New Delhi, ISBN: 978-81-7409- 232-3.

3. Singh, R. P., Switchgear and Power System Protection, PHI Learning, New Delhi, ISBN: 978-81-203-3660-5.

4. Gupta. J. B. Switchgear and Protection, S. K. Kataria and Sons, New Delhi, ISBN: 978-93-5014- 372-8.

5. Bhavesh R. Bhalja, R. P. Maheshwari,Nilesh G Chothani ; Protection and Switchgear (Second edition) Oxford University Press; New Delhi; ISBN: 13: 978-0-19-947067-9

6. C L Wadhwa; Electrical Power System (Seventh Edition); New Age International Publishers; New Delhi; ISBN: 978-93-86070-19-7

7. Ram, Badri; Vishwakarma D. N., Power System Protection and Switchgear, McGraw-Hill, New Delhi. ISBN : 9780071077743

8. Ingole Arun; Switchgear and Protection; Pearson

Course Outcomes

The theory and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

1. Identify various types of faults in power system and apply the knowledge to calculate the fault current.

2. Understand the construction and working of various types of current interrupting devices and apply suitably for different applications.

3. Understand construction and working of various types of protective relays and their applications.

4. Know about the protection systems of alternators, transformers. Busbars, Motors.

5. Understand different protection schemes for power system against over voltages.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva-voce, Assignment: 10 Marks	Attendance: 10

External Assessment (End Semester Examination:60 Marks)	
GROUP	UNIT
A	1,2
B	3
C	4,5

Course Code	:	EEPE204
Course Title	:	SWITCHGEAR AND PROTECTION LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Maintain switchgear and protection schemes used in electrical power systems.

Course contents

List of Practical:(**at least EIGHT are to be done)**
1. Identify various components of different switchgears (through visit or video or model) viz A. Circuit Breaker [: i) LT air circuit breaker; ii) Minimum Oil Circuit Breaker; iii) Air Blast Circuit Breaker; iv) SF6 Circuit Breaker; v) Vacuum Circuit Breaker] B. Isolator [vertical break, horizontal break] C. CTs and PTs D. Power and distribution Transformers **and write their specifications**
2. Test HRC fuse by performing the load test
3. Test MCB by performing the load test
4. Dismantle MCCB/ELCB/ RCCB and identify various parts
5. Testing of Induction type/ Microprocessor Based Over Current relay using Relay Testing Kit to plot the inverse characteristics.
6. Testing of static distance protection relay using Relay Testing Kit.
7. Testing of static Overcurrent protection relay using Relay Testing Kit.
9. Testing of Directional Over Current Relay (DOCR) by Relay Testing Kit.
10. Testing of percentage Differential Protection of Transformer Using Transformer Differential Relay (Electromagnetic/Microprocessor based/ static).
11. Simulate differential protection scheme for transformer with power system simulation kit.
12. Demonstrate the operation of single phasing preventer by creating single phasing fault for a given 3-ph induction motor with D.O.L. starter.
13. Simulate transmission line protection by using the impedance relay/over current relay for various faults. (On transmission line protection simulation Kit).
14. Study of different lightning arrester and identify different parts.
15. Study of ACB/VCB and identify different parts.

Course outcomes:

The practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

a) Select suitable switchgears for different applications.

b) Test the performance of different protective relays.

c) Maintain protection systems of alternators and transformers.

d) Apply the knowledge of different protection schemes through simulation.

e) Select suitable arrester against lightning.

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. **Continuous Internal Assessment of 60 marks** is to be carried out by the teachers throughout the fourth Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks
2. **External Assessment (end Semester examination) of 40 marks** shall be held at the end of the fourth Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Course Code	:	PR 202
Course Title	:	Minor Project
Number of Credits	:	1 (L: 0, T: 0, P:2)
Prerequisites	:	Knowledge of subjects up to 3rd Semester of Electrical Engineering.
Course Category	:	PR

Course Objective:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Design and development of small electrical and electronics device/equipment.

Project group:

1. Formation of project group: Maximum **6 students per batch**.
2. Each project group should select work by consulting the guide.

Activity:

1. a) Study of IC 555 and develop different multivibrator circuits using IC 555 and IC741.
b) Design of single-phase transformer of different voltage ratio and different rating upto 1KVA

AND

2. a) Develop different analog and digital electronics-based circuit as assigned by teacher.

OR

b) Develop model/ circuit/ software simulation for verification of different electrical laws / network theorem or as assigned by teacher.

OR

c) Construct single phase transformer of different voltage ratio and different rating upto 1KVA.

References:

1. A K Sawhney; A course in Electrical Machine Design; Dhanpat Rai & Co.
2. Raina Bhattacharya; Electrical Design, Estimating and Costing; New Age International Publishers
3. V. Rajini and V.S. Nagarajan; Electrical Machine Design; Pearson
4. Bhattacharya Chatterji; Projects in Electrical, Electronics, Instrumentation and computer Engineering.

Course outcome:

i. Develop proper planning to achieve the project goal.
ii. Collect relevant information and resources.
iii. Identify and apply proper techniques.
iv. Analyse the performance of project output.
v. Organize the Written documentation of the project work

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. Continuous Internal Assessment of 60 marks is to be carried out by the teachers throughout the fourth Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks

2. External Assessment (end Semester examination) of 40 marks shall be held at the end of the fourth Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20