Teaching Scheme and Syllabus

For

Bachelor of Technology

In Electrical Engineering

Minors in Electrical Engineering

Department of Electrical Engineering

Sardar Vallabhbhai National Institute of Technology

Minor in Electrical Engineering

B. Tech./M.Sc., 4th Semester (Second Year)					
Sr. No.	**Subject Code**	**Subject Name**	**Scheme (Th-Tu-P)**	**Credits**	**Specific Note [If Any]**
1	EE281	Electrical Circuits (for B.Tech.- CE, ME, ChE, Ind. Che., MaC)	3-1-0	4	
2	EE282	Electrical Machines (for B.Tech.- AI, CSE, ECE, EC-VLSI, Engg. Phy.)	3-0-2	4	
B. Tech./M.Sc., 5th Semester (Third Year)					
3	EE381	Electrical Machine (CE, ME, ChE, IndChe, MaC students)	3-0-2	4	
4	EE380	Power Systems (AI, CSE, ECE, ECVLSI, EnggPhy students)	3-0-2	4	
B. Tech./M.Sc., 6th Semester (Third Year)					
5	EE380	Power Systems (CE, ME, ChE, IndChe, MaC students)	3-0-2	4	
6	EE382	Power Electronics (AI, CSE, ECE, ECVLSI, EnggPhy students)	3-0-2	4	
B. Tech./M.Sc., 7th Semester (Fourth Year)					
7	EE481	Electrical and Electronic Measurements (CE, ME, ChE, IndChe, MaC students)	3-0-2	4	
8	EE481	Electrical and Electronic Measurements (AI, CSE, ECE, ECVLSI, EnggPhy students)	3-0-2	4	
9	EE4XX	Mini Project	0-0-4	2	

B. Tech. II year, Semester IV
ELECTRICAL CIRCUITS (For Minor Degree)
(For B. Tech. CE, ME, ChE, IndChe, MaC students)

L	T	P	Credit
3	1	0	04

EE281 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	able to apply various techniques like mesh and nodal analysis and network theorems for circuit problems
CO2	explain the principles of magnetic circuits and solve the series and parallel ac circuits
CO3	analyze poly-phase circuits
CO4	calculate various parameters of two port network and inter relationship between them.
CO5	develop a mathematical model (differential equations) of a given electric circuit and solve it

2. Syllabus

- **ELECTRICAL NETWORKS ANALYSIS** **(10 Hours)**
  Kirchhoff's Voltage Law, Kirchhoff's Current Law, independent and dependent sources, Mesh current and Nodal Voltage analysis, Super position theorem, Thevenin's theorem, Norton's theorem, Reciprocity theorem, Maximum power transfer theorem
- **MAGNETISM AND ANALYSIS OF AC CIRCUITS** **(12 Hours)**
  Faradays law, Lenz law, self-inductance, mutual inductance, coefficient of mutual inductance, coefficient of coupling, inductance in series, parallel, series-parallel, Analysis of coupled coils, dot rule, conductively coupled equivalent circuit. Complex algebra and its application to circuit analysis, R-L, R-C, R-L-C series and parallel circuits, series and parallel resonance.
- **POLYPHASE CIRCUITS** **(08 Hours)**
  Balanced three phase systems, star and mesh connections, calculations for balanced and unbalanced three phase networks, poly-phase vector diagram, and measurement of power in three phase circuits.
- **TWO PORT NETWORKS** **(07 Hours)**
  Introduction two port networks, Impedance Parameters, Admittance Parameters, Hybrid Parameters, inverse hybrid parameters, Transmission Parameters, Relationships Between Parameters, Interconnection of Networks
- **AC AND DC TRANSIENTS** **(08 Hours)**
  Transient response of R-L, R-C and R-L-C circuits, complete response of RL, RC and RLC circuits to step, sinusoidal, exponential, ramp, impulse and the combinations of these excitations.

Total Hours: 45

Tutorials will be based on the coverage of the topics given in the detailed syllabus separately for 15 hours

3. Books Recommended:

1. W. H. Hayt, J. E. Kemmerly, and Durbin S. M., Engineering Circuit Analysis, Tata McGraw Hill, 6th Edition, 2006.
2. M.E. Van Valkenburg, Network Analysis, Prentice Hall, India, 3rd Edition, 2002.
3. A. Chakrabarti, Circuit Theory, Dhanpat Rai & Co., 6th Edition, 2012.
4. A. Edminister Joseph, Electrical circuits, Schaum's outline series, McGraw hill, 2nd Edition, 1983.
5. Charles K. Alaxander and Matthew N.O. Sadiku, Fundamentals of electric circuits, Tata McGraw Hill, 5th Edition, 2013.

B. Tech. II year, Semester IV
ELECTRICAL MACHINES (For Minor Degree)
(For B. Tech. AI,CSE,ECE, ECVLSI, EnggPhy students)

L	T	P	Credit
3	0	2	04

EE282 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	Explain the construction and principle of operation of the DC motors, transformers, induction motors, Synchronous generator and Fractional horse power motors.
CO2	Perform tests on the DC motors, transformers, induction motors and Synchronous generator.
CO3	Compute performance parameters of the DC motors, transformers, induction motors and Synchronous generator.
CO4	Analyze the performance of the DC motors, transformers, induction motors and Synchronous generator.
CO5	Select the machines for different real world applications
CO6	Communicate effectively through laboratory report writing, presentation and perform task as an efficient team member

2. Syllabus

- **DC MOTORS** **(08 Hours)**
  Construction and working principle, EMF equation, Torque equation, Classification of DC motors and their characteristics, Speed control, Braking, Applications.
- **Transformers** **(08 Hours)**
  Construction and working principle, Equivalent circuit, Open circuit and Short Circuit tests, Regulation and efficiency, Autotransformers, Different connections of three phase transformers.
- **THREE-PHASE INDUCTION MOTOR** **(09 Hours)**
  Construction and working principle, Equivalent Circuit, No load and Blocked rotor tests, Torque equation, Torque–slip characteristics, Speed control, Industrial applications.
- **SYNCHRONOUS GENERATOR** **(10 Hours)**
  Construction, Principle of operation and types, Various types of excitation systems, Equivalent circuit, Determination of voltage regulation by synchronous impedance method.
- **FRACTIONAL HORSE POWER MOTORS** **(10 Hours)**
  Single phase induction motors – Construction and principle of operation, Classification based on starting method, Applications in home appliances. Construction and application of Stepper motors, Servomotors and Universal motors.

Total Hours: 45

3. List Of Experiments

1. Determination of efficiency & regulation of single- phase transformer from Open circuit and

short circuit test
2. Load test on single phase transformer
3. Determination of the equivalent circuit parameters from No-Load and Blocked rotor tests of three-phase Induction Motor.
4. Load test on three-phase Induction Motor.
5. Speed control of dc shunt motor.
6. Speed torque characteristic of a D. C. Shunt motor.
7. D. C. Series motor, Speed -torque characteristic.
8. Swinburne's test
9. Regulation of an alternator by synchronous impedance method
10. To study the construction and starting method of a single phase induction motor

4. Books Recommended:

1. D.P.Kothari and I.J.Nagrath, 'Electric Machines', McGraw Hill Education Private Limited, latest Edition.
2. A Fitzgerald, Charles Kingsley, Stephen Umans, 'Electric Machinery', McGraw Hill Education, latest edition.
3. Mukherjee and Chakravorty, Electrical Machines, Dhanpat Rai Pub., New Delhi, latest edition
4. M. G. Say, The performance and design of alternating current machines, CBS Publishers and Distributors, Delhi, latest edition
5. A. E. Clayton and N. M. Hancock, The Performance and Design of Direct Current Machines, CBS Publishers

B. Tech. III year (CE, ME, ChE, IndChe, MaC) (Minor in Electrical Engineering) , Semester- V

Electrical Machine

L	T	P	CREDIT
3	0	2	04

EE381 **Scheme**

1. Course Outcomes (Cos):

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

CO1	Explain the construction and principle of operation of the DC motors, transformers, induction motors, Synchronous generator and Fractional horse power motors.
CO2	Perform tests on the DC motors, transformers, induction motors and Synchronous generator.
CO3	Compute performance parameters of the DC motors, transformers, induction motors and Synchronous generator.
CO4	Analyze the performance of the DC motors, transformers, induction motors and Synchronous generator.
CO5	Select the machines for different real world applications
CO6	Communicate effectively through laboratory report writing, presentation and perform task as an efficient team member

2. Syllabus:

- **DC MOTORS** **(08 Hours)**

  Construction and working principle, EMF equation, Torque equation, Classification of DC motors and their characteristics, Speed control, Braking, Applications.
- **TRANSFORMERS** **(10 Hours)**

  Construction and working principle, Equivalent circuit, Open circuit and Short Circuit tests, Regulation and efficiency, Autotransformers, Different connections of three phase transformers.
- **THREE PHASE INDUCTION MOTOR** **(09 Hours)**

  Construction and working principle, Equivalent Circuit, No load and Blocked rotor tests, Torque equation, Torque–slip characteristics, Speed control, Industrial applications.
- **SYNCHRONOUS GENERATOR** **(09 Hours)**

  Construction, Principle of operation and types, Various types of excitation systems, Equivalent circuit, Determination of voltage regulation by synchronous impedance method.
- **FRACTIONAL HORSE POWER MOTORS** **(09 Hours)**

  Single phase induction motors – Construction and principle of operation, Classification based on starting method, Applications in home appliances.
  Construction and application of Stepper motors, Servomotors and Universal motors.

Total Hours: 45

3. **List of Experiments:**

1. Determination of efficiency & regulation of single- phase transformer from Open circuit and short circuit test.
2. Load test on single phase transformer
3. Determination of the equivalent circuit parameters from No-Load and Blocked rotor tests of three-phase Induction Motor.
4. Load test on three-phase Induction Motor.
5. Speed control of dc shunt motor
6. Speed torque characteristic of a D. C. Shunt motor.
7. D. C. Series motor, Speed -torque characteristic.
8. Swinburne's test
9. Regulation of an alternator by synchronous impedance method
10. To study the construction and starting method of a single phase induction motor

4. **Books Recommendation:**

1. D.P.Kothari and I.J.Nagrath, 'Electric Machines', McGraw Hill Education Private Limited, latest Edition.
2. A Fitzgerald, Charles Kingsley, Stephen Umans, 'Electric Machinery', McGraw Hill Education, latest edition.
3. Mukherjee and Chakravorty, Electrical Machines, Dhanpat Rai Pub., New Delhi, latest edition
4. M. G. Say, the performance and design of alternating current machines, CBS Publishers and Distributors, Delhi, latest edition
5. E. Clayton and N. M. Hancock, The Performance and Design of Direct Current Machines,CBS Publishers

B. Tech. III year (AI,CSE,ECE, ECVLSI, IndPhy) (Minor in Electrical Engineering) ,

Semester- V

Power Systems

L	T	P	CREDIT
3	0	2	04

EE380 **Scheme**

1. Course Outcomes (Cos):

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

CO1	Classify and compare the electrical power transmission and distribution.
CO2	Estimate the cost of power generation and the cost of electricity.
CO3	Discuss various protective devices and compare them.
CO4	Analyze the performance of the underground cable.
CO5	Illustrate and the concept of lighting system and various components associated.

2. Syllabus:

- **SUPPLY SYSTEMS** **(04 Hours)**

  AC and DC power supply systems, comparison of ac and dc transmission, advantages of high transmission voltage, various systems of power supply, comparison of conductor materials in overhead system and underground cable system.

- **UNDERGROUND CABLES** **(06 Hours)**

  Underground cables, construction of cables, classification of cables, cables for three phase services, insulation resistance of a single core cable, capacitance of a single core cable, dielectric stresses in a single core cable, most economical conductor size in a cable, grading of cables, capacitance grading and inter-sheath grading, capacitance of three core cable and measurements of capacitances.

- **CHARACTERISTICS AND PERFORMANCE OF POWER TRANSMISSION LINES** **(08 Hours)**

  Conductors, types of conductors in use, bundled conductor, spacing of conductors, symmetrical and unsymmetrical spacing, equivalent spacing, transposition, types of transmission line towers and insulator string Short and medium transmission lines, Line performance, effect of capacitance, charging currents, short and medium lines, calculation by nominal-T, nominal-π and end-condenser method, regulation and efficiency, Concept of ABCD constants, evaluation of ABCD constants for short and medium line.

- **ECONOMIC ASPECTS OF POWER SYSTEM** **(07 Hours)**

  Cost of Generation and Tariff, Power factor and its effect on system economy, Power factor improvement.

- **PROTECTION OF POWER SYSTEM** **(10 Hours)**

  Rewirable fuses, HRC fuses, isolators and earthing switches, selection of fuses. Effectively grounded and ungrounded systems, resonant grounding Methods of neutral grounding, Bulk oil circuit breaker, arc controlled devices, MOCB, ACB, ABCB, SF_6 circuit breaker, vacuum circuit breaker and DC circuit breakers, circuit breaker ratings, auto-recloser, Fundamental

characteristics of relays, standard definition of relay terminologies, relay classifications, operating principles of single and double actuating quantity type electromechanical relays, directional relay, differential relay, numerical relay.

- **ILLUMINATION AND LIGHTING SYSTEM (10 Hours)**

Nature of light, visibility spectrum curve of relative sensitivity of human eye and wave length of light. Definition: Luminous flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio, reflection factor, glare, shadow, lux. Laws of illumination. Different type of lamps, construction and working of incandescent and discharge lamps – their characteristics, fittings required for filament lamp, mercury vapour lamp, fluorescent lamp, metal halide lamp, neon lamp. Calculation of number of light points for interior illumination, calculation of illumination at different points, considerations involved in simple design problems. Illumination schemes; indoor and outdoor. Illumination levels. Main requirements of proper lighting; absence of glare, contrast and shadow. General ideas about street lighting, flood lighting, monument lighting and decorative lighting, LED lighting

Tutorials will be conducted separately for 14 hours **Total Hours: 45**

3. List of Experiments:

1. To study mathematical modeling of R-L, R-L-C and complex electrical circuit using MATLAB.
2. To study mathematical modeling of 3rd order differential equation.
3. To solve differential equations using Euler's and trapezoidal rule.
4. To study short circuit analysis of overhead transmission line using MATLAB.
5. To study the operation of definite time over current relay.
6. To study the operation static over voltage relay.
7. To study ferranti effect and determine A, B, C, D parameters of short transmission line.
8. To study characteristics of electro mechanical over current relay.
9. To study characteristics of micro controller based earth fault relay.

4. Books Recommended:

1. J. Nagrath and D. P. Kothari, Modern Power System analysis, Tata McGraw Hill Publishing Company Ltd, New Delhi, 4th Edition, 2011.
2. W. D. Stevenson, Element of Power System Analysis, McGraw Hill, 4th Edition, 1982.
3. Chakrabarti, M. L. Soni, P. V. Gupta, and U. S. Bhatnagar, A Text Book on Power System Engineering, Dhanpat Rai & Co., 2012.
4. L. Wadhwa, Electric Power System, New Age International Ltd, 3rd Edition, 2010.
5. V. K. Mehta, Rohit Mehta, Principles of Power System, S. Chand & Co. 2003

B. Tech. III year (CE,ME,ChE, IndChe, MaC) (Minor in Electrical Engineering) , Semester- VI

Power Systems

L	T	P	CREDIT
3	0	2	04

EE380 **Scheme**

1. Course Outcomes (Cos):

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

CO1	Classify and compare the electrical power transmission and distribution.
CO2	Estimate the cost of power generation and the cost of electricity.
CO3	Discuss various protective devices and compare them.
CO4	Analyze the performance of the underground cable.
CO5	Illustrate and the concept of lighting system and various components associated.

2. Syllabus:

- **SUPPLY SYSTEMS** **(04 Hours)**

  AC and DC power supply systems, comparison of ac and dc transmission, advantages of high transmission voltage, various systems of power supply, comparison of conductor materials in overhead system and underground cable system.

- **UNDERGROUND CABLES** **(06 Hours)**

  Underground cables, construction of cables, classification of cables, cables for three phase services, insulation resistance of a single core cable, capacitance of a single core cable, dielectric stresses in a single core cable, most economical conductor size in a cable, grading of cables, capacitance grading and inter-sheath grading, capacitance of three core cable and measurements of capacitances.

- **CHARACTERISTICS AND PERFORMANCE OF POWER TRANSMISSION LINES** **(08 Hours)**

  Conductors, types of conductors in use, bundled conductor, spacing of conductors, symmetrical and unsymmetrical spacing, equivalent spacing, transposition, types of transmission line towers and insulator string Short and medium transmission lines, Line performance, effect of capacitance, charging currents, short and medium lines, calculation by nominal-T, nominal-π and end-condenser method, regulation and efficiency, Concept of ABCD constants, evaluation of ABCD constants for short and medium line.

- **ECONOMIC ASPECTS OF POWER SYSTEM** **(07 Hours)**

  Cost of Generation and Tariff, Power factor and its effect on system economy, Power factor improvement.

- **PROTECTION OF POWER SYSTEM** **(10 Hours)**

  Rewirable fuses, HRC fuses, isolators and earthing switches, selection of fuses. Effectively grounded and ungrounded systems, resonant grounding Methods of neutral grounding, Bulk oil circuit breaker, arc controlled devices, MOCB, ACB, ABCB, SF_6 circuit breaker, vacuum circuit breaker and DC circuit breakers, circuit breaker ratings, auto-recloser, Fundamental characteristics of relays, standard definition of relay terminologies, relay classifications, operating principles of single and double actuating quantity type electromechanical relays,

directional relay, differential relay, numerical relay.

- **ILLUMINATION AND LIGHTING SYSTEM (10 Hours)**

Nature of light, visibility spectrum curve of relative sensitivity of human eye and wave length of light. Definition: Luminous flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio, reflection factor, glare, shadow, lux. Laws of illumination. Different type of lamps, construction and working of incandescent and discharge lamps – their characteristics, fittings required for filament lamp, mercury vapour lamp, fluorescent lamp, metal halide lamp, neon lamp. Calculation of number of light points for interior illumination, calculation of illumination at different points, considerations involved in simple design problems. Illumination schemes; indoor and outdoor. Illumination levels. Main requirements of proper lighting; absence of glare, contrast and shadow. General ideas about street lighting, flood lighting, monument lighting and decorative lighting, LED lighting

Tutorials will be conducted separately for 14 hours **Total Hours: 45**

3. List of Experiments:

10. To study mathematical modeling of R-L, R-L-C and complex electrical circuit using MATLAB.
11. To study mathematical modeling of 3rd order differential equation.
12. To solve differential equations using Euler's and trapezoidal rule.
13. To study short circuit analysis of overhead transmission line using MATLAB.
14. To study the operation of definite time over current relay.
15. To study the operation static over voltage relay.
16. To study ferranti effect and determine A, B, C, D parameters of short transmission line.
17. To study characteristics of electro mechanical over current relay.
18. To study characteristics of micro controller based earth fault relay.

4. Books Recommended:

6. J. Nagrath and D. P. Kothari, Modern Power System analysis, Tata McGraw Hill Publishing Company Ltd, New Delhi, 4th Edition, 2011.
7. W. D. Stevenson, Element of Power System Analysis, McGraw Hill, 4th Edition, 1982.
8. Chakrabarti, M. L. Soni, P. V. Gupta, and U. S. Bhatnagar, A Text Book on Power System Engineering, Dhanpat Rai & Co., 2012.
9. L. Wadhwa, Electric Power System, New Age International Ltd, 3rd Edition, 2010.
10. V. K. Mehta, Rohit Mehta, Principles of Power System, S. Chand & Co. 2003

B. Tech. III year (AI, CSE, ECE, ECVLSI, IndPhy) (Minor in Electrical Engineering), Semester-VI

Power Electronics

L	T	P	CREDIT

3	0	2	04

EE382 **Scheme**

1. Course Outcomes (Cos):

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

CO1	Understand the basic principle of operation of semiconductor devices and list applications.
CO2	Analyze and compare the performance of various line commutated converters.
CO3	Analyze and design various DC-DC converters.
CO4	Design single-phase and three-phase inverters for various applications.
CO5	Develop laboratory prototype of power electronic systems.

2. Syllabus:

- **POWER SEMICONDUCTOR DEVICES AND APPLICATIONS** **(15 Hours)**

  Review of Power semiconductor devices and their static characteristics: Diode, DIAC, Thyristor, TRIAC, Power BJT, MOSFET, IGBT etc., Thyristor: Characteristics, Two transistor analogy, Gate Characteristics, and Methods of triggering, Gate and Base drive circuits - Preliminary design considerations, Ratings and protection of devices, Temperature control of power devices and heat sink design.

- **LINE COMMUTATED CONVERTERS** **(10 Hours)**

  Principle of phase control, half wave controlled rectifiers, half wave controlled rectifiers with R, R-L, R-L-E load, single phase full wave controlled converters, 2-pulse mid-point converters, 2-pulse half and fully controlled bridge converters with R, R-L, R-L-E load, Three phase converter system with diodes, 3 phase half and fully controlled bridge converters, Effect of source impedance on the performance of the converters, Dual converters. Principle of operation and analysis of AC voltage controllers with R and R-L load.

- **DC-DC CONVERTERS** **(10 Hours)**

  Basic principle of operation, Control strategies – Duty ratio control and frequency control, Types of chopper circuits, Steady state time domain analysis of different types of choppers, Principle of operation and analysis of non-isolated DC-DC converters: Buck, Boost, and Buck-Boost converters.

- **INVERTERS** **(10 Hours)**

  Single phase voltage source inverters, half bridge inverters, full bridge inverters, Steady state analysis, Voltage control in single phase inverters, 3-phase bridge inverters, Pulse width modulated inverters, Reduction of harmonics in inverters.

Total Hours: 45

3. List of Experiments:

1. Study of IGBT, MOSFET, SCR, TRIAC, DIAC Characteristics.
2. Study of Different SCR Triggering Circuit Trainer – DC, R, R-C, UJT.
3. Study of Single Phase Half Controlled Bridge Converter with R, R-L Load.
4. Study of Single Phase Fully Controlled Bridge Converter with R, R-L Load.
5. Study of Single Phase SCR Full Bridge Inverter Circuit.
6. Study of High Voltage Thyristorised Chopper.
7. Study of Single Phase AC Voltage Controller Using SCR.
8. Study of Single Phase AC Voltage Controller Using Triac.
9. Study of Single Phase Dual Converter Circuit.
10. Study of SCR DC Circuit Breaker Circuit.
11. Study of Three Phase SCR Triggering Circuit Using Tca785 IC.
12. Study of AC Solid State Relay Using IC 555, Opto Coupler & Triac.
13. Simulation of Power EC circuits in PSIM and SIMULINK.

4. Books Recommended:

1. Bimbhra P. S., "Power electronics", Khanna Publishers, New Delhi, 5th Edition, 2014.
2. Rashid M. H., "Power Electronics Circuits, Devices, and Applications", Prentice-Hall of India Pvt. Ltd., New Delhi, 4th Edition, 2014.
3. Singh M. D., Khanchandani, K. B., "Power electronics", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2nd Edition, 2006.
4. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics Converters, Applications, and Design", John Willey & Sons, Inc., 3rd Edition, 2003.

Agrawal J. P., "Power electronic systems: Theory and design", Addison Wesley Longman (Singapore) Pte. Ltd. New Delhi, 2nd Edition, 2001.

B. Tech. IV year (CE, ME, ChE, IndChe, MaC),, (Minor in Electrical Engineering) Semester- VII

Electrical and Electronics Measurements

L	T	P	CREDIT
3	0	2	04

EE481 **Scheme**

1. **Course Outcomes (Cos):**

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

CO1	Identify different standards and explain measurement techniques of resistance, inductance and capacitance.
CO2	Explain magnetic measurement techniques, discuss and analyze utilization of CT and PT.
CO3	Classify different indicating instrument.
CO4	Operate electronic meters and oscilloscope
CO5	Illustrate calibration and traceability of test equipment

2. **Syllabus:**

- **STANDARDS** **(03 Hours)**

  Standards and their classification. Electrical Standards: EMF, current, resistance and capacitance standards
- **MEASUREMENT of RESISTANCE, INDUCTANCE AND CAPACITANCE** **(08 Hours)**

  Concept of four arm bridge network, Kelvin's double bridge, Anderson bridge, Schering bridge, Wagner earthling device, Localization of cable fault using loop methods
- **MAGNETIC MEASUREMENTS** **(06 Hours)**

  Measurement of flux: ballistic galvanometer, Grassot flux meter, Hall effect devices for measurement of flux, measurement of iron loss by wattmeter method, Hibbert magnetic standard.
- **INSTRUMENT TRANSFORMERS** **(07 Hours)**

  Theory of current and voltage transformer, ratio error and phase angle, burden, turns compensation performance characteristics, testing of CT and PT and applications of CT and PT in measurement of power.
- **INDICATING INSTRUMENTS** **(07 Hours)**

  Classification, operating principles, general construction details of indicating instruments, balancing, control and damping method, theory and construction of PMMC, moving iron and electrostatic instruments, electrodynamics wattmeter.
- **ELECTRONIC METERS AND OSCILLOSCOPE** **(08 Hours)**

  DC amplifier voltmeter, AC voltmeter using rectifiers, true RMS responding voltmeter, Oscilloscope block diagram, CRT and its circuits, vertical deflection systems, delay line, multiple trace, horizontal deflection system, oscilloscope probes, Function generator.
- **CALIBRATION AND MEASUREMENT** **(06 Hours)**

  calibration and traceability of instruments, Calibration of indicating instruments using DC potentiometer, High voltage oil testing equipment, H.V. breakdown tester, Insulation resistance measurement techniques, calibration of energy meter

Total Hours: 45

3. List of Experiments:

1. To measure unknown resistance using Kelvin's Double Bridge.
2. To measure unknown inductance using Anderson Bridge
3. To calibrate voltmeter using Potentiometer.
4. To measure unknown capacitance using Schering Bridge
5. Calibration of single phase energy meter.
6. Testing of Current Transformer using Biffi's method.
7. To find out iron loss and flux density in a given sample of laminated steel core. (Lloyd fisher square)
8. To perform the operation of HV oil testing.
9. To study operation of oscilloscope and function generator.

4. Books Recommended:

1. Golding and Widdis, Electrical measurements and Measuring instruments, Wheeler books, 5th Edition.
2. A. K. Sawhney, Electrical and electronic Measurements and Instrumentation, Dhanpat Rai & Co., 17th Edition.
3. A. D. Helfrick and W. D. Cooper, Modern electronic Instrumentation and Measurement techniques, PHI, 2nd Edition, 2009.
4. D. A. Bell, Electronic Instrumentation and Measurement, Oxford Uni. Press, 3rd Edition, 2013.
5. P. Purkait, B. Biswas, S. Das and C. Koley Electrical and Electronics Measurement and Instrumentation, McGraw Hill Education, 1st Edition, 2013.

L	T	P	CREDIT
3	0	2	04

B. Tech. IV year (AI,CSE,ECE, ECVLSI, EnggPhy),

(Minor in Electrical Engineering) Semester- VII

Electrical and Electronics Measurements

EE481 **Scheme**

1. **Course Outcomes (Cos):**

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

CO1	Identify different standards and explain measurement techniques of resistance, inductance and capacitance.
CO2	Explain magnetic measurement techniques, discuss and analyze utilization of CT and PT.
CO3	Classify different indicating instrument.
CO4	Operate electronic meters and oscilloscope
CO5	Illustrate calibration and traceability of test equipment

2. **Syllabus:**

- **STANDARDS** **(03 Hours)**

  Standards and their classification. Electrical Standards: EMF, current, resistance and capacitance standards
- **MEASUREMENT of RESISTANCE, INDUCTANCE AND CAPACITANCE** **(07 Hours)**

  Concept of four arm bridge network, Kelvin's double bridge, Anderson bridge, Schering bridge, Wagner earthling device, Localization of cable fault using loop methods
- **MAGNETIC MEASUREMENTS** **(06 Hours)**

  Measurement of flux: ballistic galvanometer, Grassot flux meter, Hall effect devices for measurement of flux, measurement of iron loss by wattmeter method, Hibbert magnetic standard.
- **INSTRUMENT TRANSFORMERS** **(06 Hours)**

  Theory of current and voltage transformer, ratio error and phase angle, burden, turns compensation performance characteristics, testing of CT and PT and applications of CT and PT in measurement of power.
- **INDICATING INSTRUMENTS** **(08 Hours)**

  Classification, operating principles, general construction details of indicating instruments, balancing, control and damping method, theory and construction of PMMC, moving iron and electrostatic instruments, electrodynamics wattmeter.
- **ELECTRONIC METERS AND OSCILLOSCOPE** **(08 Hours)**

  DC amplifier voltmeter, AC voltmeter using rectifiers, true RMS responding voltmeter, Oscilloscope block diagram, CRT and its circuits, vertical deflection systems, delay line, multiple trace, horizontal deflection system, oscilloscope probes, Function generator.
- **CALIBRATION AND MEASUREMENT** **(07 Hours)**

  calibration and traceability of instruments, Calibration of indicating instruments using DC potentiometer, High voltage oil testing equipment, H.V. breakdown tester, Insulation resistance measurement techniques, calibration of energy meter

Total Hours: 45

3. **List of Experiments:**

1. To measure unknown resistance using Kelvin's Double Bridge.
2. To measure unknown inductance using Anderson Bridge
3. To calibrate voltmeter using Potentiometer.
4. To measure unknown capacitance using Schering Bridge
5. Calibration of single phase energy meter.
6. Testing of Current Transformer using Biffi's method.
7. To find out iron loss and flux density in a given sample of laminated steel core. (Lloyd fisher square)
8. To perform the operation of HV oil testing.
9. To study operation of oscilloscope and function generator.

4. Books Recommended:

1. Golding and Widdis, Electrical measurements and Measuring instruments, Wheeler books, 5th Edition.
2. A. K. Sawhney, Electrical and electronic Measurements and Instrumentation, Dhanpat Rai & Co., 17th Edition.
3. A. D. Helfrick and W. D. Cooper, Modern electronic Instrumentation and Measurement techniques, PHI, 2nd Edition, 2009.
4. D. A. Bell, Electronic Instrumentation and Measurement, Oxford Uni. Press, 3rd Edition, 2013.
5. P. Purkait, B. Biswas, S. Das and C. Koley Electrical and Electronics Measurement and Instrumentation, McGraw Hill Education, 1st Edition, 2013.