

SYLLABUS

CHOICE BASED CREDIT SYSTEM

B. SC. WITH ELECTRONICS (General/Regular)

University of Burdwan

Details of Courses Under Undergraduate Program (B.Sc.)

Course	*Credits	
	Theory+ Practical	Theory+Tutorials
<u>I. Core Course</u> (12 Papers) 04 Courses from each of the 03 disciplines of choice	12X4= 48	12X5=60
Core Course Practical / Tutorial* (12 Practical/ Tutorials*) 04 Courses from each of the 03 Disciplines of choice	12X2=24	12X1=12
<u>II. Elective Course</u> (6 Papers) Two papers from each discipline of choice including paper of interdisciplinary nature.	6x4=24	6X5=30
Elective Course Practical / Tutorials* (6 Practical / Tutorials*) Two Papers from each discipline of choice including paper of interdisciplinary nature	6 X 2=12	6X1=6
<u>III. Ability Enhancement Courses</u>		
1. Ability Enhancement Compulsory (2 Papers) Environmental Studies	4 X 1=4	4 X1=4
English/MIL Communication	2 X 1=2	2 X1=2
2. Skill Enhancement Course (Skill Based) (4 Papers of 2 credits each)	4 X 2=8	4 X 2=8
	<hr/> Total credit= 122	<hr/> Total credit= 122

**Proposed Scheme for choice based credit system in B. Sc. with
Electronics**

	CORE COURSE (12)	Ability Enhancement Compulsory Course (AECC)	Skill Enhancement Course (SEC) (4)	Discipline Specific Elective DSE(6)
I	Electronic circuits and pcb designing (CC- 1A)	Environmental Studies		
	CC- 2 A			
	CC- 3 A			
II	Practical Electronics (CC-1B)	(English/MIL Communication)		
	CC- 2 B			
	CC- 3 B			
III	Digital System Design (CC-1C)		SEC-1	
	CC- 2 C			
	CC- 3 C			
IV	Communication Systems (CC-1D)		SEC -2	
	CC- 2 D			
	CC- 3 D			
V			SEC -3	DSE-1 A
				DSE-2 A
				DSE-3 A

VI			SEC -4	DSE-1 B
				DSE-2 B
				DSE-3 B

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	Environmental Studies	4
	Core course-IA	Electronic Circuits and PCB Designing	4
	Core Course-IA Practical	Electronic Circuits and PCB Designing Lab	2
	Core course-IIA (Other discipline)	CC 2A	6
	Core Course-IIIA (Other discipline)	CC 3A	6
II	Ability Enhancement Compulsory Course-II	English/MIL communications	2
	Core course-IB	Practical Electronics	4
	Core Course-IB Practical/Tutorial	Practical Electronics Lab	2
	Core course-2B (Other discipline)	CC-2B	6
	Core Course-3B (Other discipline)	CC-3B	6
III	Core course-1C	Digital System Design	4
	Core Course-1C Practical	Digital System Design Lab	2
	Core course-2C	CC-2C	6
	Core Course-3C	CC-3C	6
	Skill Enhancement Course -1	SEC-1	2
IV	Core course-1D	Communication Systems	4
	Course-1D Practical	Communication Systems Lab	2
	Core course-2D (Other discipline)	CC-2D	6
	Core course-3D (Other discipline)	CC-3D	6
	Skill Enhancement Course -2	SEC -2	2
V	Skill Enhancement Course -3	SEC -3	2
	Discipline Specific Elective -1	DSE-1A	6
	Discipline Specific Elective -2	DSE-2A	6
	Discipline Specific Elective -3	DSE-3A	6
VI	Skill Enhancement Course -4	SEC -4	2
	Discipline Specific Elective -4	DSE-1B	6
	Discipline Specific Elective -5	DSE-2B	6
	Discipline Specific Elective-6	DSE-3B	6
Total Credits			122

B.Sc. with Electronics

1 credit = 1 hour/week for theory; 2 hours/week for practical

Core papers Electronics (Credit: 06 each) (CP 1-4):

- | | |
|--|--------------|
| 1. Electronic Circuits and PCB Designing | Semester-I |
| 2. Practical Electronics | Semester-II |
| 3. Digital System Design | Semester-III |
| 4. Communication Systems | Semester-IV |

Discipline Specific Elective papers (Credit: 06 each) (DSE 1, DSE 2): Choose 2
(One each from Semesters – V and VI)

1. Electronic Instrumentation **Semester-V**
2. Digital Signal Processing **Semester-VI**

Skill Enhancement Course (any four) (Credit: 02 each)- SEC 1 to SEC 4

- | | |
|---|--------------|
| 1. Renewable Energy and Energy harvesting | Semester-III |
| 2. Applied Optics | Semester-IV |
| 3. Computational Physics Skills | Semester-V |
| 4. Electrical circuits and network Skills | Semester-VI |

For Papers having practical, distribution of 75 marks be as follows:

i) Class Attendance cum Internal Assessment : 20% of 75 marks = 15 marks of which 5 marks be reserved for theoretical class attendance in the following manner:

- Attendance 50% & above but below 60% - 2 marks
- Attendance 60% & above but below 75% - 3 marks
- Attendance 75% & above but below 90% - 4 marks
- Attendance 90% & above - 5 marks

and 10 marks be reserved for class test/assignment/seminar (theoretical-5 & practical-5).

ii) 20 marks be allotted for Semester-end- Practical Examination of each paper, distribution of which may be as under:

- a) Lab. Note Book : 05 Marks
- b) Viva- voce : 05 Marks
- c) Experiment : 10 marks

iii) 40 marks be allotted for Semester-end-Theoretical Examination of each paper (Duration of Exam : 2 hours), distribution of which may be as under:

- a) Answer 05 questions out of 08 carrying 02 marks each = $05 \times 02 = 10$
- b) Answer 02 questions out of 04 carrying 05 marks each = $02 \times 05 = 10$
- c) Answer 02 questions out of 04 carrying 10 marks each = $02 \times 10 = 20$

However, questions, carrying 5 or 10 marks, need not necessarily to be a single question.

For each SEC paper, distribution of 50 marks be as follows:

i) Internal Assessment : 20% of 50 marks = 10 marks be reserved for class test/assignment/ seminar.

ii) 40 marks be allotted for Semester-end-Theoretical Examination of each paper (Duration of Exam : 2 hours), distribution of which may be as under:

- a) Answer 05 questions out of 08 carrying 02 marks each = $5 \times 2 = 10$
- b) Answer 02 questions out of 04 carrying 05 marks each = $2 \times 5 = 10$
- c) Answer 02 questions out of 04 carrying 10 marks each = $2 \times 10 = 20$

However, questions, carrying 5 or 10 marks, need not necessarily to be a single question.

Mode of Practical Examination

Centre: Concerned College

Convener: The convener for each practical paper is to be nominated by the UGBS.

Examiners: One internal examiner of the concerned college and one external examiner are to be nominated by the UGBS. However, if any nominated external examiner does not accept the offer due to unavoidable circumstances to be substantiated by the document through proper channel, the Chairman of the UGBS can nominate the external examiner with the consultation of the convener.

Semester-I

CP-1: Electronic Circuits and PCB Designing (Credits: Theory-04, Practicals-02)

F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Total Lectures 60

Unit-1

(12 Lectures)

Network theorems (DC analysis only): Review of Ohms law, Kirchhoff's laws, voltage divider and current divider theorems, open and short circuits.

Thevenin's theorem, Norton's theorem and interconversion, superposition theorem, maximum power transfer theorem.

Unit 2

(13 Lectures)

Semiconductor Diode and its applications: PN junction diode and characteristics, ideal diode and diode approximations. Block diagram of a Regulated Power Supply, Rectifiers: HWR, FWR - center tapped and bridge FWRs. Circuit diagrams, working and waveforms, ripple factor & efficiency(no derivations).Filters: circuit diagram and explanation of shunt capacitor filter with waveforms.

Zener diode regulator: circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

Unit-3

(17 Lectures)

BJT and Small Signal amplifier: Bipolar Junction Transistor: Construction, principle & working of NPN transistor, terminology. Configuration: CE, CB, CC. Definition of α , β and

γ and their interrelations, leakage currents. Study of CE Characteristics, Hybrid parameters. Transistor biasing: need for biasing, DC load line, operating point, thermal runaway, stability and stability factor.

Voltage divider bias: circuit diagrams and their working, Q point expressions for voltage divider biasing.

Small signal CE amplifier: circuit, working, frequency response, re model for CE configuration, derivation for A_v , Z_{in} and Z_{out} .

Unit-4

(18 Lectures)

Types of PCB: Single sided board, double sided, Multilayer boards, Plated through holes technology, Benefits of Surface Mount Technology (SMT), Limitation of SMT, Surface mount components: Resistors, Capacitor, Inductor, Diode and IC's.

Layout and Artwork: Layout Planning: General rules of Layout, Resistance, Capacitance and Inductance, Conductor Spacing, Supply and Ground Conductors, Component Placing and mounting, Cooling requirement and package density, Layout check.

Basic artwork approaches, Artwork taping guidelines, General artwork rules: Artwork check and Inspection.

Laminates and Photoprinting: Properties of laminates, Types of Laminates, Manual cleaning process, Basic printing process for double sided PCB's, Photo resists, wet film resists, Coating process for wet film resists, Exposure and further process for wet film resists, Dry film resists

Etching and Soldering: Introduction, Etching machine, Etchant system. Principles of Solder connection, Solder joints, Solder alloys, Soldering fluxes. Soldering, Desoldering tools and Techniques.

Suggested Books:

1. Electronic Devices and circuit theory, Robert Boylestad and Louis Nashelsky, 9th Edition, 2013, PHI
2. B. C. Sarkar and S. Sarkar, Analog Electronics: Devices and Circuits, Damodar Group (Publishers),Burdwan, ISBN:9385775057 (2016)
3. Electronics text lab manual, Paul B. Zbar.
4. Electric circuits, Joeseeph Edminister, Schaum series.
5. Basic Electronics and Linear circuits, N.N. Bhargava, D.C. Kulshresta and D.C Gupta -TMH.
6. Electronic devices, David A Bell, Reston Publishing Company/DB Tarapurwala Publ.
7. Walter C.Bosshart "PCB DESIGN AND TECHNOLOGY" Tata McGraw Hill Publications, Delhi. 1983
8. Clyde F.Coombs "Printed circuits Handbook" III Edition, McGraw Hill.

Electronic Circuits and PCB Designing Lab (Hardware and Circuit Simulation Software)

60 lectures

1. Verification of Thevenin's theorem

2. Verification of Super position theorem
3. Verification of Maximum power transfer theorem.
4. Half wave Rectifier – without and with shunt capacitance filter.
5. Centre tapped full wave rectifier – without and with shunt capacitance filter.
6. Zener diode as voltage regulator – load regulation.
7. Transistor characteristics in CE mode – determination of r_i , r_o and β .
8. Design and study of voltage divider biasing.
9. Designing of an CE based amplifier of given gain
10. Designing of PCB using artwork, its fabrication and testing.
11. Design, fabrication and testing of a 9 V power supply with zener regulator

Semester-II

CP-2: Practical Electronics (Credits: Theory-04, Practicals-02)

F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Total Lectures 60

Unit-1

(10 Lectures)

Timer and PLL: Functional block diagram of 555 timer, Monostable operation and its Application, Astable operation and its Applications,

Phase Locked Loop: Functional block diagram – Phase detector / Comparator, Voltage Controlled Oscillator, Low pass filter, Applications: Frequency multiplier/ Division, AM detection

Unit-2

(16 Lectures)

Operational Amplifier: Inverting and non-inverting amplifier, Op-amp parameters, Summing Amplifier, Difference Amplifier, Integrator, Differentiator, Instrumentation Amplifier, Audio Amplifier(LM386), Voltage to current converter, Current to Voltage converter, Sample and Hold circuits.

First order active filters (Circuit diagram and formula only): low pass, high pass, band pass, band reject and all pass filters.

Phase-shift & Wein bridge oscillator using op-amp.

Unit-3

(14 Lectures)

Transducers (Basic Working): Displacement transducers - Resistive (Potentiometric,

Strain Gauges – Types, Gauge Factor, bridge circuits, Semi-conductor strain gauge) Capacitive (diaphragm), Hall effect sensors, magneto-strictive transducers, Microphone, Touch Switch, Piezoelectric sensors, light(photo-conductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature(electrical and non-electrical), Pressure sensor.

A-D and D-A Conversion: D-A conversion: 4 bit binary weighted resistor type, circuit and working. Circuit of R-2R ladder- Basic concept. A-D conversion characteristics, successive approximation ADC. (Mention the relevant ICs for all).

Unit-4

(20 lectures)

Data Acquisition using Arduino: Arduino: Birth, Open Source community, Functional Block Diagram, Functions of each Pin, Arduino Development Boards: IDE, I/O Functions, Looping Techniques, Decision Making Techniques, Designing of 1st sketch, Programming of an Arduino (Arduino ISP) , Serial port Interfacing, Basic Interfacing and I/O Concept, Interfacing LED, Switch, 7seg LED, different sensors.

Suggested Books:

1. Measurement Systems, 4/e, Doebelin McGraw Hill, New York, 1992.
2. B. C. Sarkar and S. Sarkar, Analog Electronics: Devices and Circuits, Damodar Group (Publishers), Burdwan, ISBN:9385775057 (2016)
3. Electrical Measurements & Electronic Measurements by A.K. Sawhney
4. Instrumentation- Devices and Systems By Rangan, Sarma, and Mani, Tata-McGraw Hill
5. Electronic Instrumentation by H.S Kalsi, McGraw Hill
6. Instrumentation measurements and analysis by Nakra & Choudhary
6. Measurement & Instrumentation- DVS Murthy
7. R. A. Gayakwad, Op-Amps and Linear IC's, Pearson Education (2003)
8. Electronic Sensor Circuits and Projects, III Volume, Forrest M Mims, Master Publishing Inc.
9. Timer, Op Amp, and Optoelectronic Circuits & Projects, Forrest M Mims, Master Publishing Inc.
10. Exploring Arduino, Jeremy Blum, Wiley
11. Beginning Arduino, Michael McRoberts, Technology in Action
12. Beginning Arduino Programming, Brian Evans ,Technology in Action
13. Practical Arduino Engineering, Harold Timmis, Technology in Action
14. Practical Arduino : Cool Projects for open source hardware, Jonathan Oser, Hugh Blemings, Technology in Action

Practical Electronics Lab (Hardware and Circuit Simulation Software)

60 Lectures

1. Study of basic monostable multivibrator
2. Study of basic astable multivibrator
3. Light detection using 555 timer
4. Rain alarm using 555 timer
5. Motor control by PWM using 555 timer

6. LED flasher circuit using 555 timer
7. Analog lightwave Transmitter/Receiver using 555 timer
8. Study of basic inverting and non-inverting amplifier
9. Study of basic integrator circuit
10. Study of basic differentiator circuit
11. Design of first order LPF
12. Study of first order HPF
13. Designing of fiber optic based Transmitter /Receiver using LM386
14. Temperature to voltage converter using 741.
15. Shadow sensing using 741
16. Light based PWM using 741 and V-F converter
17. Test the different Arduino Boards, Open-Source and Arduino Shields.
18. Install Arduino IDE and its development tool.
19. Develop a program to Blink LED for 1second.
20. Develop a program to interface Input Switches and output LEDs with development board (arduino).
21. Interface 7 segment display with development board(arduino)
22. Interface LM35 temperature sensor with arduino and monitor temperature on serial monitor.
23. Interface DC motor using L293D Motor Driver.
24. Interfacing of various sensors with arduino development board

Semester-III

CP-3: Digital System Design (Credits: Theory-04, Practicals-02)

F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Total Lectures 60

Unit-1

(15 lectures)

Number System and Codes: Decimal, Binary, Hexadecimal, Octal, BCD, Conversions, Complements (1's and 2's), Signed and unsigned numbers, addition and subtraction, multiplication and subtraction, Gray Codes

Boolean algebra and Logic gates: Boolean algebra- Positive and negative logic. Boolean laws. De Morgan's theorems, simplification of Boolean expressions-SOP and POS. Logic gates- basic logic gates- AND, OR, NOT, logic symbol and truth table. Derived logic gates (NAND, NOR, XOR & XNOR). Universal property of NOR and NAND gates. K-map-3 and 4 variable expressions. Characteristics of logic families: Fan In and Fan out, power dissipation and noise Immunity, propagation delay, comparison of TTL and CMOS families.

Unit-2

(11 lectures)

Combinational logic analysis and design: Multiplexers and Demultiplexers, Adder (half and full) and their use as subtractor, Encoder and Decoder, Code Converter (Binary to BCD and vice versa)

Unit-3

(16 lectures)

Sequential logic design: Latch, Flip flop, S-R FF , J-K FF, T and D type FFs, clocked FFs, registers, Counters (ripple, synchronous and asynchronous, ring, modulus)

Unit-4

(18 Lectures)

VHDL: A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools, Test Benches.

VHDL: Module, Delays, brief description - data flow style, behavioral style, structural style, mixed design style, simulating design.

Language Elements, Introduction, Keywords, Identifiers, White Space Characters, Comments, format, Integers, reals and strings. Logic Values, Data Types-net types, undeclared nets, scalars and vector nets, Register type, Parameters. Operands, Operators, types of Expressions

Gate level modeling, built in Primitive Gates, multiple input gates, Tri-state gates, pull gates, MOS switches, bidirectional switches, gate delay, array instances, implicit nets, Illustrative Examples (both combinational and sequential logic circuits).

Suggested books:

1. M. Morris Mano Digital System Design, Pearson Education Asia,(Fourth Edition)
2. Thomas L. Floyd, Digital Fundamentals, Pearson Education Asia (1994)
3. W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)
4. R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw- Hill (1994)
5. A Verilog HDL Primer – J. Bhasker, BSP, 2003 II Edition.
6. Verilog HDL-A guide to digital design and synthesis-Samir Palnitkar, Pearson, 2nd edition.

Digital System Design Lab (Hardware and Circuit Simulation Software)**60 lectures**

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate IC's.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven segment display driver.
6. Design a 4 X 1 Multiplexer using gates.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
8. Design a counter using D/T/JK Flip-Flop.
9. Design a shift register and study Serial and parallel shifting of data.

VHDL

1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Clocked D FF, T FF and JK FF (with Reset inputs).
5. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.
6. Decoder (2x4, 3x8), Encoders and Priority Encoders.
7. Design and simulation of a 4 bit Adder.
8. Code converters (Binary to Gray and vice versa).
9. 2 bit Magnitude comparator.
10. 3 bit Ripple counter.

Skill Enhancement Course

SEC-1 : RENEWABLE ENERGY AND ENERGY HARVESTING

(Credits: 02)

F.M. = 50 (Theory - 40, Internal Assessment – 10)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05] Theory: 30 Lectures

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. **(3 Lectures)**

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. **(6 Lectures)**

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. **(3 Lectures)**

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. **(3 Lectures)**

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. **(2 Lectures)**

Geothermal Energy: Geothermal Resources, Geothermal Technologies. (2 Lectures)

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. (2 Lectures)

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power (4 Lectures)

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications (2 Lectures)

Carbon captured technologies, cell, batteries, power consumption (2 Lectures)

Environmental issues and Renewable sources of energy, sustainability. (1 Lecture)

Demonstrations and Experiments

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference

Books:

- Non-conventional energy sources, B.H. Khan, McGraw Hill
- Solar energy, Suhas P Sukhative, Tata McGraw - Hill Publishing Company Ltd.
- Renewable Energy, Power for a sustainable future, Godfrey Boyle, 3rd Edn., 2012, Oxford University Press.
- Renewable Energy Sources and Emerging Technologies, Kothari et.al., 2nd Edition, PHI Learning.
- Solar Energy: Resource Assesment Handbook, P Jayakumar, 2009
- J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy

Semester-IV

CP-4: Communication Systems (Credits: Theory-04, Practicals-02)

F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Total Lectures 60

Unit-1

(16 Lectures)

Noise and Transmission lines: Noise-Introduction, internal and external noises, signal to noise ratio and noise figure

Amplitude Modulation/demodulation techniques: Block diagram of electronic communication system. Modulation-need and types of modulation-AM, FM & PM. Amplitude modulation – representation, modulation index, expression for instantaneous voltage, power relations, frequency spectrum, DSBFC, DSBSC and SSBSC (mention only). Limitations of AM.

Demodulation- AM detection: principles of detection, linear diode, principle of working and waveforms.

Block diagram of AM transmitter and Receiver.

Unit-2

(12 Lectures)

Frequency Modulation/demodulation techniques: Frequency Modulation: definition, modulation index, FM frequency spectrum diagram, bandwidth requirements, frequency deviation and carrier swing, FM generator-varactor diode modulator.

FM detector – principle, slope detector-circuit, principle of working and waveforms. Block diagram of FM transmitter and Receiver. Comparison of AM and FM.

Unit- 3

(16 Lectures)

Digital communication: Introduction to pulse and digital communications, digital radio, sampling theorem, types- PAM, PWM, PPM, PCM – quantization, advantages and applications, digital modulations (FSK, PSK, and ASK). Advantage and disadvantages of digital transmission, characteristics of data transmission circuits – Shannon limit for information capacity, bandwidth requirements, data transmission speed, noise, cross talk, echo suppressors, distortion and equalizer, MODEM– modes, classification, interfacing (RS232). TDMA, FDMA, CDMA concepts, comparison of TDMA and FDMA

Unit- 4

(16 Lectures)

Cellular Communication: Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers (ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data encryption, architecture (block diagram) of cellular mobile communication network, CDMA technology, CDMA overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.

Satellite communication: Introduction, to Orbit, types of orbits, Block diagram of satellite transponder.

Suggested Books:

1. Electronic Communication, George Kennedy, 3rd edition, TMH.
2. B. C. Sarkar and S. Sarkar, Analog Electronics: Devices and Circuits, Damodar Group (Publishers),Burdwan, ISBN:9385775057 (2016)
3. Electronic Communication, Roddy and Coolen, 4th edition, PHI.
4. Electronic Communication systems, Kennedy & Davis, IV edition-TATA McGraw Hill.
5. Advanced Electronic Communication systems, Wayne Tomasi- 6th edition, Low priced edition- Pearson education

Communication Systems Lab

60 Lectures

1. Amplitude modulator and Amplitude demodulator
2. Study of FM modulator using IC8038
3. Study of VCO using IC 566
4. Study of Time Division Multiplexing and de multiplexing
5. Study of AM Transmitter/Receiver
6. Study of FM Transmitter/Receiver
7. ASK modulator and demodulator
8. Study of FSK modulation
9. Study of PWM and PPM
10. Study of PAM modulator and demodulator

Skill Enhancement Course

SEC-2 : Applied Optics

(Credits: 02)

F.M. = 50 (Theory - 40, Internal Assessment – 10)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05] Theory: 30 Lectures

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

(i) Sources and Detectors (9 Periods)

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

Experiments on Lasers:

- a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.

- b. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
- c. To find the polarization angle of laser light using polarizer and analyzer
- d. Thermal expansion of quartz using laser

Experiments on Semiconductor Sources and Detectors:

- a. V-I characteristics of LED
- b. Study the characteristics of solid state laser
- c. Study the characteristics of LDR
- d. Photovoltaic Cell
- e. Characteristics of IR sensor

(ii) Fourier Optics (6 Periods)

Concept of Spatial frequency filtering, Fourier transforming property of a thin lens

Experiments on Fourier Optics:

a. Fourier optic and image processing

- 1. Optical image addition/subtraction
- 2. Optical image differentiation
- 3. Fourier optical filtering
- 4. Construction of an optical 4f system

b. Fourier Transform Spectroscopy

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

Experiment:

To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.

(iii) Holography (6 Periods)

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition

Experiments on Holography and interferometry:

- 1. Recording and reconstructing holograms
- 2. Constructing a Michelson interferometer or a Fabry Perot interferometer
- 3. Measuring the refractive index of air
- 4. Constructing a Sagnac interferometer
- 5. Constructing a Mach-Zehnder interferometer
- 6. White light Hologram

(iv) Photonics: Fibre Optics (9 Periods)

Optical fibres and their properties, Principal of light propagation through a fibre, Thenumerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating **Experiments**

on Photonics: Fibre Optics

- a. To measure the numerical aperture of an optical fibre

- b. To study the variation of the bending loss in a multimode fibre
- c. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern
- d. To measure the near field intensity profile of a fibre and study its refractive index profile
- e. To determine the power loss at a splice between two multimode fibre

Reference Books:

- LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill• Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- Optical Electronics, Ajoy Ghatak and K. Thyagarajan, 2011, Cambridge University Press
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.

Semester-V

Discipline Specific Elective

DSE-1: Electronic Instrumentation

(Credits: Theory-04, Practicals-02)

F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Theory: 60 Lectures

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Shielding and grounding. Electromagnetic Interference. **(4 Lectures)**

Basic Measurement Instruments: DC measurement-ammeter, voltmeter, ohm meter, AC measurement, Digital voltmeter systems (integrating and non-integrating). Digital Multimeter; Block diagram principle of measurement of I, V, C. Accuracy and resolution of measurement. **Measurement of Impedance-** A.C. bridges, Measurement of Self Inductance (Anderson's bridge), Measurement of Capacitance (De Sauty's bridge), Measurement of frequency (Wien's bridge). **(14 Lectures)**

Power supply: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators (78XX and 79XX), Line and load regulation, Short circuit protection. Idea of switched mode power supply (SMPS) and uninterrupted power supply (UPS).

(5 Lectures)

Oscilloscope: Block Diagram, CRT, Vertical Deflection, Horizontal Deflection. Screens for CRT, Oscilloscope probes, measurement of voltage, frequency and phase by Oscilloscope. Digital Storage Oscilloscopes. LCD display for instruments. **(10 Lectures)**

Lock-in-amplifier: Basic Principles of phase locked loop (PLL), Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor), lock and capture. Basic idea of PLL IC (565 or 4046). Lock-in-amplifier, Idea of techniques for sum and averaging of signals. **(8 Lectures)**

Signal Generators: Function generator, Pulse Generator, (Qualitative only).

(3 Lectures)

Virtual Instrumentation: Introduction, Interfacing techniques (RS 232, GPIB, USB), Idea about Audrino microcontroller and interfacing software like lab View).

(5 Lectures)

Transducers: Classification of transducers, Basic requirement/characteristics of transducers, Active and Passive transducers, Resistive (Potentiometer- Theory, temperature compensation & applications), Capacitive (variable air gap type), Inductive (LVDT) & piezoelectric transducers. Measurement of temperature (RTD, semiconductor IC sensors), Light transducers (photo resistors & photovoltaic cells).
(11 Lectures)

Reference

Books:

- W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
 - E.O. Doebelin, Measurement Systems: Application and Design, McGraw Hill Book - fifth Edition (2003).
 - David A. Bell, Electronic Devices and Circuits, Oxford University Press (2015).
 - Alan S. Morris, “Measurement and Instrumentation Principles”, Elsevier (Butterworth Heinmann-2008).
 - S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill (1998).
 - Introduction to measurements and instrumentation, 4th Edn., Ghosh, PHI Learning
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PRACTICALS -DSE LAB: ELECTRONIC INSTRUMENTATION LAB

60

Lectures

AT LEAST 05 EXPERIMENTS FROM THE FOLLOWING

1. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
2. Measurement of Capacitance by De Sauty’s bridge
3. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.)
4. To determine the Characteristics of LVDT.
5. To determine the Characteristics of Thermistors and RTD.
6. Measurement of temperature by Thermocouples.

7. Design a regulated power supply of given rating (5 V or 9V).
8. To design and study the Sample and Hold Circuit.
9. To plot the frequency response of a microphone.

Reference

Books:

- W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
- David A. Bell, Electronic Instrumentation & Measurements, Prentice Hall (2013)
- S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata McGraw Hill (1998).
- Basic Electronics:A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1990, Mc-Graw Hill

Skill Enhancement Course

SEC-3: COMPUTATIONAL PHYSICS SKILLS

(Credits: 02)

F.M. = 50 (Theory - 40, Internal Assessment – 10)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05]

Theory: 30 Lectures

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics and Science.

- *Highlights the use of computational methods to solve physical problems*
- *Use of computer language as a tool in solving physics/science problems*
- *Course will consist of hands on training on the Problem solving on Computers.*

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. **Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of $\sin(x)$ as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal. **(4 Lectures)**

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration

and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems. **(5 Lectures)**

Control Statements: Types of Logic(Sequential, Selection, Repetition), Branching Statements (Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using $\exp(x)$ series evaluated at $x=1$ **(6 Lectures)**

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. **(6 Lectures)**

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices

4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

(9 Lectures)

Reference

Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
 - Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
 - LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
 - Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
 - Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
 - Computational Physics: An Introduction, R. C. Verma, etal. New Age International Publishers, New Delhi(1999)
 - Elementary Numerical Analysis, K.E.Atkinson,3rd Edn., 2007, Wiley India Edition.
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Semester-VI

Discipline Specific Elective

DSE-2: Digital Signal Processing

(Credits: Theory-04, Practicals-02)

F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Theory: 60 Lectures

Discrete-Time Signals and Systems: Classification of Signals, Transformations of the Independent Variable, Periodic and Aperiodic Signals, Energy and Power Signals, Even and Odd Signals, Discrete-Time Systems, System Properties. Impulse Response, Convolution Sum; Graphical Method; Analytical Method, Properties of Convolution; Commutative; Associative; Distributive; Shift; Sum Property System Response to Periodic Inputs, Relationship Between LTI System Properties and the Impulse Response; Causality; Stability; Invertibility, Unit Step Response. **(10 Lectures)**

Discrete-Time Fourier Transform: Fourier Transform Representation of Aperiodic Discrete-Time Signals, Periodicity of DTFT, Properties; Linearity; Time Shifting; Frequency Shifting; Differencing in Time Domain; Differentiation in Frequency Domain; Convolution Property. **The z -Transform:** Bilateral (Two-Sided) z -Transform, Inverse z -Transform, Relationship Between z -Transform and Discrete-Time Fourier Transform, z -plane, Region-of-Convergence; Properties of ROC, Properties; Time Reversal; Differentiation in the z -Domain; Power Series Expansion Method (or Long Division Method); Analysis and Characterization of LTI Systems; Transfer Function and Difference-Equation System. Solving Difference Equations. **(15 Lectures)**

Filter Concepts: Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters, Simple IIR Digital Filters, All pass Filters, Averaging Filters, Notch Filters. **(5 Lectures)**

Discrete Fourier Transform: Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property; Parseval's Relation, Linear Convolution Using the DFT (Linear Convolution Using Circular Convolution), Circular Convolution as Linear Convolution with aliasing. **(10 Lectures)**

Fast Fourier Transform: Direct Computation of the DFT, Symmetry and Periodicity Properties of the Twiddle factor (WN), Radix-2 FFT Algorithms; Decimation-In-Time (DIT) FFT Algorithm; Decimation-In-Frequency (DIF) FFT Algorithm, Inverse DFT Using FFT Algorithms. **(5 Lectures)**

Realization of Digital Filters: Non Recursive and Recursive Structures, Canonic and Non Canonic Structures, Equivalent Structures (Transposed Structure), FIR Filter structures; Direct-Form; Cascade-Form; Basic structures for IIR systems; Direct-Form I.

Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR and IIR Filters; Difference Between FIR and IIR Filters, Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters, Impulse Responses of Ideal Filters, Windowing Method; Rectangular; Triangular; Kaiser Window, FIR Digital Differentiators.

Infinite Impulse Response Digital Filter: Design of IIR Filters from Analog Filters, IIR Filter Design by Approximation of Derivatives, Backward Difference Algorithm, Impulse Invariance Method. **(15 Lectures)**

Reference

Books:

- Digital Signal Processing, Tarun Kumar Rawat, 2015, Oxford University Press, India
- Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
- Principles of Signal Processing and Linear Systems, B.P. Lathi, 2009, 1st Edn. Oxford University Press.
- Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.
- Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.
- Digital Signal Processing Principles Algorithm & Applications, J.G. Proakis and D.G. Manolakis, 2007, 4th Edn., Prentice Hall.

PRACTICAL-DSE LAB: DIGITAL SIGNAL PROCESSING LAB

60 Lectures

At least 06 experiments from the following using Scilab. Introduction to Numerical computation software Scilab be introduced in the lab.

1. Write a program to generate and plot the following sequences: (a) Unit sample sequence $\delta(n)$, (b) unit step sequence $u(n)$, (c) ramp sequence $r(n)$, (d) real valued exponential sequence

$$x(n) = (0.8)^n u(n) \text{ for } 0 \leq n \leq 50.$$

2. Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for $N = 5$

$$x(n) = \text{rect}\left(\frac{n}{2N}\right) = \Pi\left(\frac{n}{2N}\right) = \begin{cases} 1 & -N \leq n \leq N \\ 0 & \text{otherwise} \end{cases}$$

3. An LTI system is specified by the difference equation

$$y(n) = 0.8y(n-1) + x(n)$$

(a) Determine $H(e^{j\omega})$

(b) Calculate and plot the steady state response $y_{ss}(n)$ to

$$x(n) = \cos(0.5\pi n)u(n)$$

4. Given a casual system

$$y(n] = 0.9y(n-1) + x(n)$$

(a) Find $H(z)$ and sketch its pole-zero plot

(b) Plot the frequency response $|H(e^{j\omega})|$ and $\angle H(e^{j\omega})$.

5. Design a digital filter to eliminate the lower frequency sinusoid of $x(t) = \sin 7t + \sin 200t$. The sampling frequency is $f_s = 500 \text{ Hz}$. Plot its pole zero diagram, magnitude response, input and output of the filter.

6. Let $x(n)$ be a 4-point sequence:

$$x(n) = \{1, 1, 1, 1\} = \begin{cases} 1 & 0 \leq n \leq 3 \\ 0 & \text{otherwise} \end{cases}$$

Compute the DTFT $X(e^{j\omega})$ and plot its magnitude

(a) Compute and plot the 4 point DFT of $x(n)$

(b) Compute and plot the 8 point DFT of $x(n)$ (by appending 4 zeros)

(c) Compute and plot the 16 point DFT of $x(n)$ (by appending 12 zeros)

7. Let $x(n)$ and $h(n)$ be the two 4-point sequences,

$$x(n) = \{1, 1, 1, 1\}$$

$$h(n) = \{1, -1, -1, 1\}$$

Write a program to compute their linear convolution using circular convolution.

8. Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 KHz . Take the length of the impulse response as 17.

9. Design an FIR filter to meet the following specifications:

passband edge $F_p = 2 \text{ KHz}$

stopband edge $F_s = 5 \text{ KHz}$

Passband attenuation $A_p = 2 \text{ dB}$

Stopband attenuation $A_s = 42 \text{ dB}$

Sampling frequency $F_s = 20 \text{ KHz}$.

10. The frequency response of a linear phase digital differentiator is given by

$$H_d(e^{j\omega}) = j\omega e^{-j\tau\omega} \quad |\omega| \leq \pi$$

Using a Hamming window of length $M = 21$, design a digital FIR differentiator. Plot the amplitude response.

Reference Books:

1. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press, India.
2. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
3. Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.
4. Getting started with MATLAB, Rudra Pratap, 2010, Oxford University Press.
5. Modern Digital Signal Processing includes Signals and Systems, Udayashankara, 2nd Edn., PHI Learning.
6. Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
7. Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.

Skill Enhancement Course

SEC-4: Electrical Circuits and Network Skills

(Credits: 02)

F.M. = 50 (Theory - 40, Internal Assessment – 10)

Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05]

Theory: 30 Lectures

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. (3 Lectures)

Electrical Circuits: Basic electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. (4 Lectures)

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.
(4 Lectures)

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. **(3 Lectures)**

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. **(4 Lectures)**

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources **(3 Lectures)**

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Relay protection device. **(4 Lectures)**

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, and solder. Preparation of extension board. **(5 Lectures)**

Reference Books:

- Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
 - A text book in Electrical Technology - B L Theraja - S Chand & Co.
 - A text book of Electrical Technology - A K Theraja
 - Performance and design of AC machines - M G Say ELBS Edn.
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