UNIVERSITY OF DELHI

CNC-II/093/1(40)/EC-1270/2024-25/162
Dated: 07.08.2024

**NOTIFICATION**

Sub: Amendment to Ordinance V

[ECR No. 5-24/ dated 27.07.2024]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

**Add the following:**

The syllabus of DSEs Papers for B.Sc. Physical Science (Electronics) with physics and electronics as core papers under the UGCF, is being notified herewith for the information of all concerned as under:

| | |
|---|---|
| **Semester-III** (***As per Annexure-1***) | 1. BASICS OF INTERNET OF THINGS AND PYTHON PROGRAMMING<br>2. ELECTRONIC INSTRUMENTATION<br>3. RENEWABLE ENERGY AND ENERGY HARVESTING-2 |
| **Semester-IV** (***As per Annexure-2***) | 1. ADVANCED DIGITAL ELECTRONICS PSE 4TH SEMESTER-2<br>2. PHYSICS OF ELECTRICAL MACHINES<br>3. INTRODUCTION TO EMBEDDED SYSTEM DESIGN |
| **Semester-V** (***As per Annexure-3***) | 1. DIGITAL SIGNAL PROCESSING<br>2. SEMICONDUCTOR DEVICES FABRICATION<br>3. VERILOG AND FPGA BASED SYSTEM DESIGN |
| **Semester-VI** (***As per Annexure-4***) | 1. ANTENNA THEORY AND WIRELESS NETWORK<br>2. PHOTONIC DEVICES AND POWER ELECTRONICS<br>3. RESEARCH METHODOLOGY |

**REGISTRAR**

# Basics of Internet of things and Python Programming
## DSE (Electronics) Sem III
## (For Physics and Electronics as core subjects )

**Credit: 04 (Theory-02, Practical-02)**

**Course Learning Objectives:**

The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects. The course will also help the student to develop python programming skills for IoT and examine programming with Raspberry PI.

**Course Learning Outcomes:**

At the end of this course, students will be able to achieve the following learning outcomes:

1. The student will be able to describe various IoT enabled technologies.

2. The student will be able to describe understand the concepts of M2M with necessary protocols

3. Illustrate Python Programming for IoT

4. Examine the Python Programming with Raspberry PI

## Syllabus- Theory

**Unit I : Introduction to IoT:** Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Business processes in IoT (like ;Supply chain management,Predictive maintenance, Data management, energy management etc) (**7 Lectures)**

**Unit II : Elements of IoT:** Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python) for Communication Protocols-MQTT, ZigBee, Bluetooth, TCP**. (7 Lectures)**

**Unit III : Introduction to Python:** Language Features of Python, data Types, data structures, control of flow, functions, modules, packaging, file handling, data/time operations and classes.(**9 Lectures)**

**Unit IV : IoT Physical devices and Endpoints:** Introduction to Raspberry PI- Interface(Serial, SPI) programming- Python program with raspberry PI with focus of interfacing external gadgets, controlling output and reading input from pins.(**7 Lectures**)

**Reference Books:**

1.Vijay Madisetti, Arshdeep Bahga, Ïnternet of Things, —A Hands on Approachǁ, University Press

2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, —Introduction to Internet of Things: A practical Approachǁ, ETI Labs

3. Pethuru Raj and Anupama C. Raman, —The Internet of Things: Enabling Technologies, Platforms, and Use Casesǁ, CRC Press

4. Jeeva Jose, —Internet of Thingsǁ, Khanna Publishing House, Delhi

5. Adrian McEwen, —Designing the Internet of Thingsǁ, Wiley

6. Raj Kamal, —Internet of Things: Architecture and Designǁ, McGraw Hill 7. Cuno Pfister, —Getting Started with the Internet of Thingsǁ, O Reilly Media

7. Getting started with Raspberry PI, Matt Richardson and Shawn Wallace, O'Reilly (SPD), 2014, ISBN : 9789350239759

**Practicals (Any five to be performed) :**

1. To interface LED/Buzzer with Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
2. To interface Push button/Digital sensor (IR/LDR) with Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
3. To interface DHT11 sensor with Raspberry Pi and write a program to print temperature and humidity readings.
4. To interface Bluetooth with Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
5. To interface Bluetooth with Raspberry Pi and write a program to turn LED ON/OFF when ‗1'/'0' is received from smartphone using Bluetooth.
6. Write a program on Raspberry Pi to publish temperature data to MQTT broker.
7. Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print

# ELECTRONIC INSTRUMENTATION
## DSE (Electronics) Sem III
## (For Physics and Electronics as core subjects )

Total Credits: 04 (Credits: Theory: 02, Practical: 02)
Total Hours: Theory: 30, Practical: 60

Course Objective

• This course aims to provide an exposure on basics of measurement and instrumentation and its various aspects and their usage through hands-on mode.
• It also aims to provide exposure of various measurement instruments such as power supply, oscilloscope, multivibrators, signal generators are discussed in detail.
• It also aims to develop an understanding of virtual instrumentation and transducers.

Course Learning Outcomes

At the end of this course, students will have understanding of:
• basic principles of the measurement and errors in measurement, specifications of basic Measurement instruments and their significance with hands on mode.
• principles of voltage measurement, advantages of electronic voltmeter over conventional multimeter in terms of sensitivity etc.
• measurement of impedance using bridges, Power supply, Filters, IC regulators and Load and line regulation.
• Specifications of CRO and their significance, the use of CRO and DSO for the measurement of voltage (dc and ac), frequency and time period.
• Multivibrators, working circuits of Astable and monostable multivibrators.
• Phase Locked Loop (PLL), Voltage controlled oscillators and lock-In amplifier.
• explanation and specifications of Signal and pulse Generators
• the Interfacing techniques, Audrino microcontroller & interfacing software, Understanding and usage of Transducers.

Unit 1 (12 Lectures)

Measurements: Shielding and grounding. Electromagnetic Interference. 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. 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).

Unit 2 (6 Lectures)

Power supply: Using IC Regulators (78XX and 79XX), Line and load regulation, Short circuit protection. Idea of switched mode power supply (SMPS) & uninterrupted power supply (UPS). Oscilloscope: Block Diagram, CRT, Deflection (Qualitative). Screens for CRT, Oscilloscope probes, measurement of voltage, frequency, and phase by Oscilloscope. Digital Storage Oscilloscope.

Unit 3 (4 Lectures)

Multivibrators (IC 555): Block diagram, Astable & Monostable multivibrator circuits. Signal Generators: Function generator (Black Box Approach)

Unit 4 (8 Lectures)
Virtual Instrumentation: Introduction, Interfacing techniques (RS 232, GPIB, USB). Idea about Audrino microcontroller & interfacing software like lab View). Transducers: Classification of transducers. Measurement of temperature (RTD, semiconductor IC sensors), Light transducers (photo resistors & photovoltaic cells).

PRACTICALS-LAB: ELECTRONIC INSTRUMENTATION LAB
"Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the lab, including necessary precautions.
Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors. Application to the specific experiments done in the lab."
At least 08 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. Design a regulated power supply of given rating (5 V or 9V).
4. To determine the Characteristics of LVDT.
5. To determine the Characteristics of Thermistors and RTD.
6. Measurement of temperature by Thermocouples.
7. To design an Astable Multivibrator of given specification using IC 555 Timer.
8. To design a Monostable Multivibrator of given specification using IC 555 Timer.
9. To design and study the Sample and Hold Circuit.
10. To plot the frequency response of a microphone.
11. Glow an LED via USB port of PC.
12. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.
References for Theory
Essential Readings
1. Electronic Instrumentation and Measurement Techniques, W.D. Cooper and A. D. Helfrick, Prentice Hall (2005).
2. Measurement Systems: Application and Design, E.O.Doebelin, McGraw Hill Book - fifth Edition (2003).
3. Electronic Devices and Circuits, David A. Bell, Oxford University Press (2015).

Additional Readings
1. Instrumentation Devices and Systems, S. Rangan, G. R. Sarma and V. S. Mani, Tata McGraw Hill(1998).

References for Laboratory
1. "Measurement and Instrumentation Principles", Alan S. Morris, Elsevier (Butterworth Heinmann-2008).
2. Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller,

# Renewable Energy and Energy Harvesting
# DSE (Electronics) Sem III
# (For Physics and Electronics as core subjects )

**Credit: 04 (Theory-02, Practical-02)**

**Course Objective**

1. To provide knowledge and practical learning experiences about various alternative energy sources.
2. To explore methods of harnessing energy from wind, solar, mechanical, ocean, geothermal, and other sources, and review the functioning of different energy harvesting systems installed globally.

**Course Learning Outcomes**

At the end of this course, students will be able to achieve the following learning outcomes:

1. Gain knowledge of various energy sources for harvesting.
2. Understand the necessity of energy conversion and the different methods of energy storage.
3. Develop a thorough understanding of various renewable energy systems and their components.
4. Acquire knowledge about renewable energy technologies, different storage technologies, distribution grids, smart grids, including sensors, regulation, and control.
5. Design models for wind energy or solar energy plants.
6. Gain hands-on experience with:
   - Different types of alternative energy sources.
   - Converting vibration into voltage using piezoelectric materials.
   - Converting thermal energy into voltage using thermoelectric modules.

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**Unit 1 (3 Lectures)**

Fossil fuels and Alternate Sources of energy: Fossil fuels, their limitation, need of renewable energy, non-conventional energy sources. An overview of energy conversions using Offshore Wind Energy, Tidal Energy, solar energy, biomass, bio-gas generation, geothermal energy tidal energy, Hydroelectricity.

**Unit 2 (10 Lectures)**

Solar energy: Solar energy, its importance, solar spectrum and AM 1.5 radiation, storage of solar energy, solar pond, applications of solar pond and solar energy, Principle & working of solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell. Need and characteristics of photo-voltaic (PV) systems, PV models and equivalent circuits.

**Unit 3 (3 Lectures)**

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

**Unit 4 (7 Lectures)**

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide Energy Technologies, Ocean Thermal Energy, Ocean Bio-mass. Geothermal Energy: Geothermal Resources.
Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. Rain water harvesting.

**Unit 5 (7 Lectures)**

Piezoelectric Energy harvesting: Principle of piezoelectric effect, polarization tensor, and strain parameters, Piezoelectric materials (ZnO and PZT) and their characteristics, Piezoelectric generators and energy harvesting applications,

Electromagnetic Energy Harvesting: Linear generators, recent applications: Carbon captured technologies.

**PRACTICALS**

"Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the lab, including necessary precautions.

Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors. Application to the specific experiments done in the lab."

Teacher may give a long duration project based on this paper.

Demonstrations and Experiments:

1. Demonstration of Training modules on Solar energy,etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage-driven thermo-electric modules.
4. Demonstration of wind energy modules.

References for Theory/ Essential Readings

1. Solar energy, Suhas P Sukhative, Tata McGraw - Hill Publishing Company Ltd.
2. Renewable Energy, Power for a sustainable future, Godfrey Boyle, 3rd Edn., 2012, Oxford University Press.

Additional Readings

1. Solar Energy: Resource Assessment Handbook, P Jayakumar, 2009
2. J.Balfour, M.Shaw and S. Jarosek, Photo-voltaics, Lawrence J Goodrich (USA).
3. http://en.wikipedia.org/wiki/Renewable_energy

References for Laboratory

1. Non-conventional energy sources, B.H. Khan, McGraw Hill 60

# DSE (Electronics) Sem IV
# (For Physics and Electronics as core subjects )

**Credit: 04 (Theory-02, Practical-02)**

## ADVANCED DIGITAL ELECTRONICS (DSE)

| Course Title | Credits | Credit distribution of the course | | | Eligibility Criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | | |
| Advanced Digital Electronics (DSE) | 4 | 2 | 0 | 2 | Class XII Pass with Science | Basic Electronics |

## LEARNING OBJECTIVES

*This paper aims to cover the overall topics in Digital Electronics and is offered as elective papers in this curriculum. In this course, students will be able to understand the working principle of CRO, Analog and Digital circuits, 555 timer, Counters, Programmable Logic Devices. In addition, students will get an Introduction to basic principle of MOS transistor and basic CMOS Inverter*

## LEARNING OUTCOMES

At the end of this course, students will be able to achieve the following learning outcomes.

- To understand the internal structure of CRO and its usage to measure the Voltage, Current, Frequency, and Phase Difference.
- Knowledge of Active and Passive components and scale of integration.
- To understand the use and applications of the 555 timer.
- Knowledge about various types of 4-bit counters.
- D/A and A/D conversion.
- Variety of memories, Programmable Logic Devices and Digital Logic families

## THEORY COMPONENT

### Unit 1

**Introduction to CRO:** Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. **(3 Lectures)**

**Analog & Digital Circuits**

Integrated Circuits (Qualitative Treatment only) :- Active and Passive components. Discrete

Circuit Component. Wafer. Chip. Advantages and Drawbacks of ICs. Scale of integration : SSI, MSI, LSI and VLSI (Basic Idea and Definitions Only). Classification of ICs. Fabrication of Components on Monolithic ICs. Difference between Analog and Digital Circuits , Examples of Linear and Digital ICs. **(5 Lectures)**

### Unit 2

**Timers**:IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. **(3 Lectures)**

**Counters(4 bits):** Asynchronous counter, Synchronous Counter, Ring Counters, Decade Counter. **(3 Lectures)**

D-A and A-D Conversion: 4 bit binary weighted and R-2R D-A converters, Accuracy and Resolution**,** A-D conversion characteristics, sampling techniques, successive approximation ADC. **(4 Lectures)**

### Unit 3

**Memories:** ROM, PROM, EPROM, EEPROM, Bipolar RAM, static and dynamic RAM, Memory Expansion (Word size and Word Capacity). **(4 Lectures)**

**Programmable Logic Devices:** Combinational circuit Implementation using PROM, PLA and PAL. **(2 Lectures)**

Introduction to basic principle of MOS transistor and basic CMOS Inverter. **(2 lectures)**

**Digital Logic families:** Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison. **(4 Lectures)**

**References:**
**Essential Readings:**


1. Digital Principles and Applications, A.P.Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw.
2. Digital Fundamentals, 3rd Edition by Thomas L. Floyd (Universal Book Stall, India, 1998).
3. Digital Design by M. Morris Mano, 5th edition, Pearson.
4. Digital Electronics by R.P. Jain.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.


## PRACTICAL COMPONENT

**(15 Weeks with 4 hours of laboratory session per week)**

**Do any 6 of the following experiments.**

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To design an astable multivibrator of given specifications using 555 Timer.
3. To design a monostable multivibrator of given specifications using 555 Timer and to measure the Pulse-Width of its output.
4. Design an asynchronous Up/Down counter using D Flip Flop.
5. Design an asynchronous Up/Down counter using JK Flip Flop.
6. Design a synchronous Up/Down counter using D Flip Flop.
7. Design a synchronous Up/Down counter using JK Flip Flop.
8. Design and study of R-2R DAC.
9. Design and study of ADC.

**Additional Readings:**


1. Digital design by M. Morris Mano, 5th edition, Pearson.

2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

3. Digital Electronics G K Kharate ,2010, Oxford University Press.

4. Digital Computer Electronics, A. P. Malvino, J.A. Brown, 3rd Edition, 2018, Tata McGraw Hill Education.

# Physics of Electrical Machines
# DSE (Electronics) Sem IV
# (For Physics and Electronics as core subjects )

**Credit: 04 (Theory-03, Practical-01)**

(Credits: Theory-03, Practicals-01)

Theory Lectures 45

Unit- 1 **DC Machines:** (18 Lectures)

Basic constructional features and physical principles involved in electrical machines, armature winding (ac and dc), lap and wave connections, different types of pitches

**D.C. Generators:**

Construction and principles of operation of dc generator, brief idea about armature action and commutation, E.M.F. Equation, Characteristics of Separately and Self excited (Shunt, Compound and Series) generators, Losses and efficiency, applications.

**D.C. Motors:**

Comparison of generator and motor action & interchangeability, principle of operation, significance of back EMF, maximum power, Torque and speed relation, Characteristics of series, shunt and Compound excited motors & applications, losses & efficiency, necessity of motor starters, Three point starter, Speed control of DC motors, electronic speed control of DC motors, electric braking

Unit-2 **Transformers:** (15 Lectures)

Types of transformers, Transformer Construction, EMF equation, No load operation, operation under load, Phasor diagram, equivalent circuit of transformer, Transformer Losses, Voltage regulation, condition for maximum efficiency, All day efficiency, Short circuit and open circuit tests, Auto transformers. Three phase transformers, line and phase relations for Y-Y, delta-delta, delta –Y and Y-delta connection

Unit- 3 **Induction Motors** (12 Lectures)

Uniform and oscillating magnetic field production using Helmholtz's coil, Rotating magnetic field (Ferrari's Principle), Three Phase Induction Motors: General constructional features, Types of rotors,Induction motor as a generalized transformer, equivalent circuit, Production of torque, Slip, Torque equation, Torque-slip characteristics, Speed control of Induction motor. Comparison with DC motor

**Single Phase Motors**: Single phase induction motors, Construction, principle of operation based on starting methods, Split phase motors, capacitor start motors, capacitor start & run motors, Reluctance Motor, Stepper Motor, Single phase a.c. series motors, Universal motor.

**Suggested Books:**


1. A. E. Fitzgerald, Charles Kingsley, Jr. and Stephen D. Umans, Electric Machinery, McGraw
2. I. J. Nagrath and D. P. Kothari, Electrical Machines, Tata McGraw Hill.
3. G. Mc. Pherson, An introduction to Electrical Machines & Transformers, John Wiley & Sons.
4. H. Cotton, Advanced Electrical Technology, CBS Publishers and Distributors, New Delhi.
5. S. Ghose, Electrical Machines, Pearson Education.
6. N. K. De and P. K. De, Electric Drives, Prentice Hall of India.
7. P. C. Sen, Principles of Electric Machines and Power Electronics, Wiley.
8. Abhijit Chakrabarti, Sudipt Rath and Chandan Kumar Chanda, Basic Electrical Engineering, Tata McGraw-Hill Publishing Company Limited New Delhi.

**Physics of Electrical Machines Lab**

1. Study of performance characteristics of DC Series motor by conducting load test.
2. Study of performance characteristics of DC Shunt motor.by conducting load test.
3. Study of characteristics of single phase induction motor.
4. Study of characteristics of three phase induction motor.
5. Study of control of DC motor using SCR.
6. To perform Open Circuit Test and short circuit test on single phase transformer and find equivalent circuit parameters. Find the efficiency at various loads. Draw efficiency versus load curve. Find out the load at which is the maximum efficiency. Calculate the voltage regulation at full load, at power factor (i) 0.85 lagging and (ii) 0.85 leading.
7. To connect two single phase transformers in parallel and to obtain the data to study the load sharing of the transformers..
8. To connect three single phase transformers in various forms of three phase transformer connections and verify the voltage relationships.
9. To perform load test on a single phase transformer and determine (i) Polarity of primary and secondary Windings, (ii) Voltage ratio of transformer (iii) Voltage regulation of transformer.

Books:

1. N. K. Jain, A textbook of practicals in Electrical Engineering, Dhanpat Rai Publishing Company
2. S. G. Tarnekar et al, Laboratory courses in Electrical Engineering, S. Chand
3. S. K. Bhattacharya and K. M. Rastogi, Experiments in Basic Electrical Engineering, New Age International
4. T. Thyagrajan, Basic Electrical Engineering, Scitech Publications

# Introduction to embedded system design
## DSE (Electronics) Sem IV
## (For Physics and Electronics as core subjects )
**Credit: 04 (Theory-02, Practical-02)**

| Course Title & Code | Credits | Credit distribution of the course | | | Pre- requisite of the course | Department offering the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | | |
| Introduction to Embedded System Design<br>GE – 16 | 4 | 2 | 0 | 2 | NIL | Physics and Astrophysics |

## LEARNING OBJECTIVES

This paper aims to introduce the basic concepts or fundamentals of embedded system design to students not majoring in physics. The course covers the comprehensive introduction to embedded systems, their role and application areas in our daily life. Basic elements needed to design a typical embedded system are discussed to provide the students a broader perspective. Specific applications of embedded systems which are a part of our daily life were discussed. In the end Arduino Uno is introduced.

## LEARNING OUTCOMES

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

- Learn about an embedded system and how it is different than a general purpose computing system like computer or laptop etc.
- The student should be able to identify various embedded systems available around us in our daily life.
- Classify embedded systems based on generation, complexity and performance, major applications areas etc.
- Explain the domains and areas of applications of embedded systems. The students should be able to get a broader perspective of different embedded systems available in industry, telecom, photography, homes, automobile, aviation and ship industry etc.
- Explain the roles and uses of various components like microcontroller, memory, sensors and actuators, interface types etc. of embedded systems.
- Know the basic characteristics and quality attributes that any typical embedded system must possess.

- This paper is designed in such a way that the students will be able to connect the textbook knowledge with basic design and working of the various embedded systems present in our daily life. By the end of this course the student will have a fairly good idea of embedded systems and the gained knowledge will be helpful in predicting the possible design and working of an unknown system. Arduino Uno is introduced so that students can learn how to use different sensors to control different processes.

## SYLLABUS OF GE - 16 THEORY COMPONENT

**UNIT – I - Introduction to Embedded Systems (3 Hours)**

Embedded systems, historical background, difference between an embedded systems and general computing systems, classification of embedded systems based on generation, complexity and performance, major applications areas, purpose of embedded systems like in data collection/storage/representation, data communication, data/signal processing, monitoring, control, application specific user interface.

**Unit – II - Elements of Embedded System (6 Hours)**

Core of the embedded system: General purpose and domain specific processors like microprocessors, microcontrollers and digital signal processors, application specific integrated circuits (ASICs), programmable logic devices (PLDs), commercial off-the-shelf components (COTS), reduced instruction set computing (RISC) and complex instruction set computing (CISC), Harvard vs Von-Neumann architecture, different types of memory (RAM, ROM, Storage etc) their classification and different versions, reset circuit, oscillator unit

**Unit – III - Peripheral devices, sensors and actuators (6 Hours)**

General discussion on light emitting diodes (LEDs), 7-segment LED display, piezo buzzer, push button switch, keypad or keyboard (discuss design using push button switches), relay (single pole single throw), LDR, thermistor, IR sensor, ultrasonic sensor, opto-coupler, DC motors, servo motor, stepper motor (unipolar and bipolar)

**Unit – IV - Communication Interface (2 Hours)**

Serial and parallel interface, universal serial bus (USB), Infra-red data transfer, bluetooth (BT), Wi-Fi, general packet radio Service (GPRS), 3G, 4G, LTE

**Unit – V - Characteristics and quality attributes of an embedded systems (3 Hours)**

Characteristics: Application and domain specific, reactive and real time, operation under harsh environments, distributed or stand alone, size and weight, power consumption Operational and non-operational attributes: response time, throughput, reliability, maintainability, security, safety, testability and debug-ability, evolvability, portability, cost and revenue

**Unit – VI - Applications of Embedded Systems (4 Hours)**

General discussion on the design and working of washing machine, refrigerator, microwave oven, automobiles, mobile phones, hearing aid device, electrocardiogram (ECG), AC or TV remote control system, smart watch, digital camera and laser printers etc.

**Unit – VII - Introduction to Arduino (6 Hours)**

Pin diagram and description of Arduino UNO, basic programming and applications

**References:**

**Essential Readings:**

1) Introduction to embedded system, K. V. Shibu, 1st edition, 2009, McGraw Hill

2) Embedded Systems: Architecture, Programming and Design, R. Kamal, 2008, Tata McGraw Hill
3) Embedded Systems and Robots, S. Ghoshal, 2009, Cengage Learning.
4) Embedded Microcomputer systems: Real time interfacing, J. W. Valvano, 2011, Cengage
Learning
5) Embedded System, B. K. Rao, 2011, PHI Learning Pvt. Ltd.

6) Programming Arduino: Getting Started with Sketches, S. Monk, 2nd edition, Mc Graw Hills

7) Arduino: Getting Started With Arduino and Basic Programming with Projects by E. Leclerc

**Additional Readings:**

1) The 8051 Microcontroller and Embedded Systems Using Assembly and C, M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, 2nd edition, 2007, Pearson Education
2) Microprocessors and Microcontrollers, K. Kant, 2nd edition, 2016, PHI learning Pvt. Ltd.
3) The 8051 Microcontroller, Ayala, 3rd edition, Cengage learning

## PRACTICAL COMPONENT

**(15 Weeks with 4 hours of laboratory session per week)**

- Every student must perform at least six experiments from the following list
- Mandatory exercise for all students: Familiarization with power supply, function generator, CRO/DSO, multimeter, bread board etc. Measure the frequency and amplitude (pp or rms) of a given signal using CRO/DSO. (The purpose is to acquaint the students with these instruments so that they can have a basic understanding of these instruments).
  ARDUINO based Experiments:
  1) Flashing LEDs ON/OFF after a given delay.
  2) Design a simple transmitter and receiver circuit using IR LED and a detector and use it for obstacle detection.
  3) Interface a simple relay circuit to switch ON and OFF a dc motor/LED.
  4) Interface DC motor to Arduin UNO and rotate it clockwise and anticlockwise.

5) Interface Servo motor to Arduin Uno and rotate it clockwise and anticlockwise for a given angle.
6) Interface an ADC and read the output of the LDR sensor. Display the value on the serial monitor.
7) To design an alarm system using an Ultrasonic sensor.
8) To design a counter/Motion sensor alarm using IR Led and Detector
9) To design a circuit to control ON/OFF of LED light using LDR.
10) To design a circuit to control ON/OFF of a process using a thermistor.
11) To design a thermistor based thermometer.
12) Control the speed of the DC motor using LDR.

**References for laboratory work:**

1) Arduino Programming: 3 books in 1 - The Ultimate Beginners, Intermediate and Expert Guide to Master Arduino Programming, R. Turner
2) Arduino: Getting Started With Arduino and Basic Programming with Projects, E. Leclerc
3) Basic Electronics: A text lab manual, P. B. Zbar, A. P. Malvino, M. A. Miller, 1994, McGraw Hill.
4) Electronic Devices and circuit theory, R. L. Boylestad and L. D. Nashelsky, 2009, Pearson
5) Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall.
6) Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper, 1990, PHI Learning.

# DIGITAL SIGNAL PROCESSING

## DSE (Electronics) Sem V
## (For Physics and Electronics as core subjects )

| Course Title & Code | Credits | Credit distribution of the course | | | Eligibility Criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | | |
| Digital Signal Processing<br><br>Physics DSE 5 | **4** | **2** | **0** | **2** | Class XII pass with Physics and Mathematics as main subjects | Basics of digital electronics and analog electronics |

## LEARNING OBJECTIVES

This paper describes the discrete-time signals and systems, Fourier transform representation of aperiodic discrete time signals. This paper also highlights the concept of filters and realization of digital filters. At the end of the syllabus, students will develop an understanding of discrete and fast Fourier transform.

## LEARNING OUTCOMES

At the end of this course, students will be able to develop following learning outcomes.

- Students will learn basic discrete-time signal and system types, convolution sum, impulse and frequency response concepts for linear time-invariant (LTI) systems.
- The student will be in position to understand use of different transforms and analyse the discrete time signals and systems. They will learn to analyse a digital system using z- transforms and discrete time Fourier transforms, region of convergence concepts, their properties and perform simple transform calculations.
- The student will realize the use of LTI filters for filtering different real world signals. The concept of transfer Function and difference-equation system will be introduced. Also, they will learn to solve difference equations.
- Students will develop an ability to analyze DSP systems like linear-phase, FIR, IIR, All-pass, averaging and notch Filter etc.

- Students will be able to understand the discrete Fourier transform (DFT) and realize its implementation using FFT techniques.
- Students will be able to learn the realization of digital filters, their structures, along with their advantages and disadvantages. They will be able to design and understand different types of digital filters such as finite and infinite impulse response filters for various applications.

## SYLLABUS OF PHYSICS DSE 5

**THEORY** **COMPONENT**

**Unit – I** **(7 Hours)**

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 and analytical method, properties of convolution (general idea), sum property system response to periodic inputs, relationship between LTI system properties and the impulse response

**Unit – II** **(9 Hours)**

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; Differentiation in the z-Domain; Power Series Expansion Method (General Idea). Transfer Function and Difference-Equation System.

**Unit – III** **(10 Hours)**

Filter Concepts: Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters.Only Qualitative treatment
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 (General Idea), Linear Convolution Using the DFT (Linear Convolution Using Circular Convolution).

**Unit – IV** **(4 Hours)**

Realization of Digital Filters: FIR Filter structures; Direct-Form; Cascade-Form Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR Filters

**References:**

**Essential Readings:**

1) Digital Signal Processing, T. K. Rawat, 2015, Oxford University Press, India
2) Digital Signal Processing, S. K. Mitra, McGraw Hill, India. st
3) Principles of Signal Processing and Linear Systems, B. P. Lathi, 1 edition, 2009, Oxford University Press.

4) Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press
5) Digital Signal Processing Principles Algorithm & Applications, J. G. Proakis and D. G. Manolakis, 4th edition, 2007, Prentice Hall.

**Additional Readings:** nd

1) Digital Signal Processing, A. Kumar
2) Digital Signal Processing, P. S. R. Diniz, E. A. B. da Silva and S. L. Netto, 2nd edition, 2017, Cambridge University Press

## PRACTICAL COMPONENT

**(15 Weeks with 4 hours of laboratory session per week)**

- Introduction to numerical computation software Scilab/Matlab/Python be introduced in the lab.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab"

**<u>At least six experiments to be performed from the following using Scilab/ Matlab/ Python</u>**

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 $x(n) = (0.8)^n u(n)$ 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

$$x(n) = rec\left(\frac{n}{2N}\right) = \prod \left(\frac{n}{2N}\right) = \{1 - N \leq n \leq N) \ other\ wise$$

3) An LTI system is specified by the difference equation *y(n)=0.8y(n-1)+x(n)*
   (a) Determine $H(e^{iw})$
   (b) Calculate and plot the steady state response *y(n)* to $x(n) = cos\ cos\ (0.5\pi n)\ u(n)$
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 $|H(e^{jw})|$ and $\angle H(e^{jw})$
5) Design a digital filter to eliminate the lower frequency sinusoid of *x(t)=sin7t+sin200t*. The sampling frequency is 500 Hz. Plot its pole zero diagram, magnitude response, input and output of the filter.
6) Let *x(n)* be a 4-point sequence:

$x(n) = \{1,1,1,1\} = \{1 \ \ 0 \leq n \leq 3\ 0 \ \ otherwise$

↑

Compute the DTFT $X(e^{jjii})$ 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)={1,2,2,1}* *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 KHz
Stopband edge $F_s$=5 KHz
Passband attenuation $A_p$=2 dB
Stopband attenuation $A_s$=42 dB
Sampling frequency $F_{sf}$=20 KHz

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

1. $H_d(e^{jw}) = jwe^{-j|w|} |w| \leq \pi$

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

# References for laboratory work:


1) A Guide to MATLAB, B. R. Hunt, R. L. Lipsman and J. M. Rosenberg, 3rd edition, 2014, Cambridge University Press.

2) Fundamentals of Digital Signal processing using MATLAB, R. J. Schilling and S. L. Harris, 2005, Cengage Learning.

3) Getting started with MATLAB, R. Pratap, 2010, Oxford University Press.

## Semiconductor Devices Fabrication

## DSE (Electronics) Sem V
## (For Physics and Electronics as core subjects )

| | | Credit distribution of the course | | | Eligibility Criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | | |
| Semiconductor Devices Fabrication | 4 | 2 | 0 | 2 | Class XII pass with Physics and Mathematics as main subjects | NIL |

### LEARNING OBJECTIVES

This course provides a review of basics of semiconductors such as energy bands, doping, defects etc. and introduces students to various semiconductor and memory devices, thin film growth techniques and processes including various vacuum pumps, sputtering, evaporation, oxidation and VLSI processing are described in detail. By the end of the syllabus, students will have an understanding of MEMS based transducers.

### LEARNING OUTCOMES

At the end of this course, students will be able to achieve the following learning outcomes.

- Learn to distinguish between single crystal, polycrystalline and amorphous materials based on their structural morphology and learn about the growth of single crystals of silicon, using Czochralski technique, on which a present day electronics and IT revolution is based.
- Students will understand about the various techniques of thin film growth and processes.
- Appreciate the various VLSI fabrication technologies and learn to design the basic fabrication process of R, C, P- N Junction diode, BJT, JFET, MESFET, MOS, NMOS, PMOS and CMOS technology.
- Gain basic knowledge on overview of MEMS (Micro-Electro-Mechanical System) and MEMS based transducers.

### THEORY COMPONENT

**Unit – I (9 Hours)**

Introduction: Review of energy bands in materials, metal, semiconductor and insulator, doping in semiconductors, defects (point, line, Schottky and Frenkel), single crystal, polycrystalline and amorphous materials, Czochralski technique for silicon single crystal growth, silicon wafer slicing and polishing.
Vacuum Pumps: Primary pump (mechanical) and secondary pumps (diffusion, turbomolecular, cryopump, sputter-ion) – basic working principle, throughput and characteristics in reference to pump selection, vacuum gauges (Pirani and Penning)

**Unit – II (10 Hours)**

Thin film growth techniques and processes: Sputtering, evaporation (thermal, electron beam)pulse laser deposition (PLD), chemical vapour deposition (CVD), epitaxial growth Thermal oxidation process (dry and wet) passivation, metallization, diffusion

**Unit – III (7 Hours)**

VLSI Processing: Clean room classification, line width, photolithography: resolution and process, positive and negative shadow masks, photoresist, step coverage, developer, electron beam lithography, etching: wet etching, dry etching (RIE and DRIE), basic fabrication process of R, C, P-N Junction diode, BJT, JFET, MESFET, MOS, NMOS, PMOS and CMOS technology, wafer bonding, wafer cutting, wire bonding and packaging issues (qualitative idea)

**Unit – IV (4 Hours)**

Micro Electro-Mechanical System (MEMS): Introduction to MEMS, materials selection for MEMS devices, selection of etchants, surface and bulk micromachining, sacrificial subtractive processes, additive processes, cantilever, membranes, general idea of MEMS based pressure, force, and capacitance transducers

**References:**

**Essential Readings:**

1) Physics of Semiconductor Devices, S. M. Sze. Wiley-Interscience.
2) Fundamentals of Semiconductor Fabrication, S.M. Sze and G. S. May, John-Wiley and Sons, Inc.
3) Introduction to Semiconductor materials and Devices, M. S. Tyagi, John Wiley & Sons 4) VLSI Fabrication Principles (Si and GaAs), S. K. Gandhi, John Wiley & Sons, Inc.

**Additional Readings:**

1) Handbook of Thin Film Technology, L. I. Maissel and R. Glang

## PRACTICAL COMPONENT

**(15 Weeks with 4 hours of laboratory session per week)**

At least six experiments to be performed from the following list

1. Deposition of thin films using dip coating and deposition of metal contacts using thermal Evaporation and study its I-V characteristics

2. Deposition of thin films using spin coating and deposition of metal contacts using thermal evaporation and study its I-V characteristics
3. Fabrication of p-n Junction diode and study its I-V characteristic
4. Create vacuum in a small tube (preferably of different volumes) using a mechanical rotary pump and measure pressure using vacuum gauges.
5. Selective etching of different metallic thin films using suitable etchants of different concentrations.
6. Wet chemical etching of Si for MEMS applications using different concentrations of etchant.
7. Calibrate semiconductor type temperature sensor (AD590, LM 35, LM 75)
8. To measure the resistivity of a semiconductor (Ge) crystal with temperature (up to 150C) by four-probe method.
9. To fabricate a ceramic and study its capacitance using LCR meter.
10. To fabricate a thin film capacitor using dielectric thin films and metal contacts and study its capacitance using LCR meter

**References for laboratory work**:

1) The science and Engineering of Microelectronics Fabrication, S. A. Champbell, 2010, Oxford University Press

2) Introduction to Semiconductor Devices, F. Kelvin Brennan, Cambridge University Press, 2010

## VERILOG AND FPGA based System design

## DSE (Electronics) Sem V
## (For Physics and Electronics as core subjects )

| Course Title & Code | Credits | Credit distribution of the course | | | Eligibility Criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | | |
| Verilog and FPGA based System Design<br><br>Physics DSE 14 | **4** | **2** | **0** | **2** | Class XII pass with Physics and Mathematics as main subjects | Basics of digital electronics |

### LEARNING OBJECTIVES

This course trains the students to use VLSI design methodologies and simulate simple digital systems. Students will understand the HDL design flow and the fundamental Verilog concepts in-lieu of today's most advanced digital design techniques. The emphasis of this course is to enhance the understanding of Programmable Logic Devices so as to implement the Digital Designs on FPGAs using Verilog HDL

### LEARNING OUTCOMES

At the end of this course, students will be able to,
- Write synthesizable Verilog code.
- Write a Verilog test bench to test Digital Logic Design.
- Design and simulate digital circuits using Verilog modules.
- Understand various types of programmable logic building blocks such as PAL, PLA,

CPLDs and FPGAs and their trade-offs.
- Design and implement digital systems on programmable logic device FPGA using

Verilog HDL.

### THEORY COMPONENT

**Unit – I (20 Hours)**

Introduction to Verilog: Introduction to HDL, importance of HDL, popularity of Verilog HDL, design flow, structure of HDL module, Verilog modules (design and stimulus), introduction to language elements - keywords, identifiers, white space, comments, format, integers, real and strings, logic values, data types, scalars and vector nets, parameters, system tasks, compiler directives

Gate level modelling: Introduction, built in primitive gates, buffers, multiple input gates, gate delays.
Data flow modelling: Continuous assignment, net declaration assignments, net delays, operator types and operators precedence

Behavioral modelling: Always and initial constructs, procedural assignment (blocking and non-blocking statements), If-else, case statements, loop structures (while, for, repeat and forever), sequential and parallel Blocks
Modelling of combinational and sequential digital circuits using different levels of abstraction

Hierarchical modelling concepts: Design methodologies, design a 4-bit adder using four 1-bit full adders

**Unit – II (10 Hours)**

Look up Tables: 2-input, 3-input and 4-input LUTs, Implement logic functions with LUT, advantages and disadvantages of lookup tables
Programmable Logic Devices: Difference between PAL and PLA, Realize simple logic functions using PAL and PLA, CPLD and FPGA architectures, types of FPGA, logic cell structure, programmable interconnects, logic blocks and I/O Ports, placement and routing, applications of FPGAs

**References:**
**Essential Readings:**
1) Verilog HDL. Pearson Education, S. Palnitkar, 2 edition, 2003
2) FPGA Based System Design. W. Wolf, Pearson Education
3) Digital Signal processing, S. K. Mitra, 1998, McGraw Hill
4) VLSI design, D. P. Das, 2nd edition, 2015, Oxford University Press.
5) Digital Signal Processing with FPGAs, U. Meyer Baese, Springer, 2004

**Additional Readings:**

1) Fundamentals of Digital Logic with Verilog Design, S. B. Zvonko Vranesic, 2016, McGraw Hill

## PRACTICAL COMPONENT

**(15 Weeks with 4 hours of laboratory session per week)**

- Session on how to write the design module and test benches using required software and simulate the combinational and sequential circuits.
- Sessions on how to configure FPGA using Verilog HDL for the final implementation of the logic design.

**At least six experiments to be performed from the following list**

1) Half adder, Full Adder using basic and derived gates.
2) Half subtractor and Full Subtractor using basic and derived gates.
3) Design and simulate 4-bit Adder using Data Flow Modeling.
4) Multiplexer (4x1) and Demultiplexer(1X4) using Data Flow Modeling.
5) Decoder and Encoder using case structure/gates.
6) Clocked D, JK and T Flip flops (with Reset inputs)
7) 4-bit Synchronous up/downCounter
8) To design and study switching circuits (LED blink shift)
9) To interface LCD using FPGA
10) To interface a multiplexed seven segment display.
11) To interface a stepper motor and DC motor.

**References for laboratory work**:

1) Digital System Designs and Practices: Using Verilog HDL and FPGAs, Ming-Bo Lin, Wiley India Pvt Ltd.

2) Verilog Digital System Design, Z. Navabi, 2nd edition, TMH
3) Designing Digital Computer Systems with Verilog, D. J. Laja and S. Sapatnekar, 2015,

Cambridge University Press nd
4) Verilog HDL primer, J. Bhasker. BSP, 2 edition, 2003

# ANTENNA THEORY AND WIRELESS NETWORK

## DSE (Electronics) Sem III
## (For Physics and Electronics as core subjects )

| Course Title & Code | Credits | Credit distribution of the course | | | Eligibility Criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | | |
| Antenna Theory and Wireless Network<br><br>Physics DSE 16 | **4** | **2** | **0** | **2** | Class XII pass with Physics and Mathematics as main subjects | Basics of digital and analog electronics and communication systems |

## LEARNING OBJECTIVES

This course gives an overview of wireless communication elements and networks. Students will develop an understanding of basics of antenna, its various parameters, its usage as a transmitter and receiver. Cellular concept and system design fundamentals are described and the evolution of current wireless systems in real world such as 2G, 3G, 4G and LTE networks is discussed.

## LEARNING OUTCOMES

At the end of this course, students will be able to achieve the following learning outcomes.
- Identify basic antenna parameter (radiating wire structures).
- Determine directions of maximum signal radiations and the nulls in the radiation patterns.
- Design array antenna systems from specifications.
- Identify the characteristics of radio-wave propagation.
- Identify wireless networks 4G and LTE, and 5G.
- Design cellular systems

## THEORY COMPONENT

**Unit – I** **(14 Hours)**

ANTENNA THEORY
Introduction: Antenna as an element of wireless communication system, antenna radiation mechanism, types of antennas, fundamentals of EMFT: Maxwell's equations and their applications to antennas
Antenna Parameters: Antenna parameters: Radiation pattern (polarization patterns, field and phase patterns), field regions around antenna, radiation parameters (general idea): intensity, beam width, gain, directivity, polarization, bandwidth, efficiency and antenna temperature

**Unit – II** **(5 Hours)**

Antenna as a transmitter/receiver: Effective height and aperture, power delivered to antenna, input impedance, general idea of radiation from an infinitesimal small current element and radiation from an elementary dipole (Hertzian dipole)

**Unit – III** **(5 Hours)**

WIRELESS NETWORKS:
Introduction: General idea of cellular and wireless systems, current wireless systems, examples of wireless communication systems, idea about global mobile communication system

**Unit – IV** **(3 Hours)**

Modern wireless communication systems: General idea 2G,3G and wi-fi, 4G and LTE, and 5G wireless networks, wireless local area networks (WLANs), bluetooth and personal area networks (PANs).

**Unit – V** **(3 Hours)**

**Cellular Concept and System Design Fundamentals:** Cellular concept and cellular system fundamentals, cellular systems design considerations (qualitative idea only)

**References:**
**Essential Readings:**
1) Antenna Theory, Ballanis, 2nd edition, 2003, John Wiley & Sons
2) Electro Magnetic Waves and Radiating Systems, Jordan and Balmain, E. C., 3rd edition,

1968, Reprint (2003), PHI
3) Fundamentals of Wireless Communication, D. Tse and P. Viswanathan, 2014, Cambridge

University Press
4) Wireless communication and Networks, U. Dalal, 2015, Oxford University Press.
5) Mobile Communication Design and Fundamentals, Lee, William C.Y., 4th edition, 1999

**Additional Readings:**

1) Wireless communications, A. Goldsmith, 2015, Cambridge University Press 2) Modern Wireless Communication, H. S. and M. M. Pearson, 3rd edition, 2005

## PRACTICAL COMPONENT

**(15 Weeks with 4 hours of laboratory session per week)**

**At least six experiments to be performed from the following list**

1) Study of simple dipole and folded dipole (l/2) antenna, plot and compare the radiation pattern of both antennas.
2) Study of simple dipole 5 element Yagi-UDA and folded dipole 5 element Yagi Uda antenna, plot and compare the radiation pattern of both antennas
3) Study of loop antenna and slot antennas and plot their radiation patterns
4) Study the radiation pattern of ground plane antenna and observe the difference in radiation pattern with single element rod, detector and reflector rods
5) To study the variation of radiated field with distance from transmitting antenna.
6) To study modulation of sine wave on RF transmitted and observe the demodulated wave
on detector receiver
7) Study of the reciprocity theorem for antennas
8) Study the role of matching stub in antenna transmission.
9) To study working of current sensor and measurement of current in various elements of antenna.

10) To study and measure SWR using various types of antennas.
11)To study different parts of a 4G Volte mobile phone and observe constellation diagram for transmitter and receiver IQ signals
12) To study various types of faults in a 4G volte mobile phone.

**References for laboratory work**:
1) Antenna Theory, Ballanis, 2nd edition, 2003, John Wiley & Sons
2) Fundamentals of Wireless Communication, D. Tse and P. Viswanathan, 2014, Cambridge University Press
3) Mobile Communication Design and Fundamentals, Lee, William C.Y., 4 edition, 1999

## PHOTONIC DEVICES AND POWER ELECTRONICS

## DSE (Electronics) Sem III
## (For Physics and Electronics as core subjects )

| Course Title & Code | Credits | Credit distribution of the course | | | Eligibility Criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | | |
| Photonic Devices and Power Electronics<br><br>Physics DSE 15 | **4** | **2** | **0** | **2** | Class XII pass with Physics and Mathematics as main subjects | Analog electronics |

### LEARNING OBJECTIVES

This paper aims to provide students with in-depth understanding of the principles, concepts, and applications of photonic devices and power electronics. The course covers a range of topics, including, semiconductor lasers, fibre optics, power diodes, power MOSFETs, and power electronics applications. Students will develop the necessary knowledge and skills to design and analyze various photonic and power electronic devices and systems. The course also emphasizes the practical aspects of device design, fabrication, and characterization, preparing students for real-world challenges and opportunities in these fields.

### LEARNING OUTCOMES

Upon completion of the course on Photonic Devices and Power Electronics, students are expected to achieve the following learning outcomes.

- Understand the basic principles and concepts of photonic devices and power electronics, including semiconductor lasers, fibre optics, power diodes, power MOSFETs, and power electronics applications.
- Develop the necessary knowledge and skills to design and analyse various photonic and power electronic devices and systems.
- Gain practical experience in device design, fabrication, and characterization.
- Apply the knowledge and skills learned in the course to real-world challenges and opportunities in the fields of photonics and power electronics.
- Develop problem-solving skills, critical thinking skills, and the ability to apply scientific and engineering principles to practical problems.

- Understand the ethical considerations and professional responsibilities associated with the development and use of photonic and power electronic devices and systems.
- Overall, students will gain a comprehensive understanding of photonic devices and power electronics and be well-equipped to pursue careers in these fields or continue their studies at the graduate level.

**THEORY COMPONENT**

**Unit – I (4 Hours)**

Classification of photonic devices: Radiative transition and optical absorption. Light Emitting Diodes (construction, materials and operation) Semiconductor LASERs: Condition for amplification, LASER cavity, LASER diode.

**Unit – II (8 Hours)**

Photodetectors: Photoconductor, photodiodes (p-i-n, avalanche) and phototransistors, quantum efficiency and responsivity
Solar Cell: Construction, working and characteristics.
LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays.

**Unit – III (4 Hours)**

Introduction to Fiber Optics: Element of an Optical Fiber Transmission link- Optical Fiber Modes and Configurations, Overview of Modes -Single Mode Fibers-Graded Index fiber structure.

**Unit – IV (8 Hours)**

Power Devices: Need for semiconductor power devices, Power MOSFET (qualitative); introduction to family of thyristors; Silicon Controlled Rectifier (SCR) - structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Gate-triggering circuits; DIAC and TRIAC- Basic structure, working and V-I characteristics

Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA)

**Unit – V (6 Hours)**

Applications of SCR: Phase controlled rectification, AC voltage control using SCR and Triac as a switch. Power Invertors- Need for commutating circuits and their various types, dc link invertors, Parallel capacitor commutated invertors.

**References:**

**Essential Readings:**

1) Optoelectronics, J. Wilson and J. F. B. Hawkes, 1996, Prentice Hall India
2) Optoelectronics and Photonics, S. O. Kasap, 2009, Pearson Education

3) Electronic Devices and Circuits, D. A. Bell, 2015, Oxford University Press
4) Introduction to fibre optics, A. K. Ghatak and K. Thyagarajan, 1998, Cambridge

University Press
5) Power Electronics, M. D. Singh and K. B. Khanchandani, Tata McGraw Hill.

**Additional Readings:**

1) Power Electronics, J. S. Chitode, Technical Publications
2) Basic Electrical and Electronics Engineering, R. Saravanakumar V. Jegathesan and K. V.

Kumar, Wiley
3) Power Electronics: Essentials & Applications, L. Umanand, Wiley

## PRACTICAL COMPONENT

**(15 Weeks with 4 hours of laboratory session per week)**

At least six experiments to be performed from the following list

1) Diffraction experiments using a LASER.
2) To determine characteristics of (a) LEDs, (b) Photovoltaic cell and (c) Photodiode.
3) To study the Characteristics of LDR and Photodiode with (i) Variable Illumination intensity, and (ii) Linear Displacement of source.
4) To measure the numerical aperture of an optical fiber.
5) Output and transfer characteristics of a power MOSFET.
6) Study of I-V characteristics of SCR.
7) SCR as a half wave and full wave rectifier with R and R - L loads.
8) AC voltage controller using TRIAC with UJT triggering.
9) Study of I-V characteristics of DIAC.
10) Study of I-V characteristics of TRIAC

**References for laboratory work**:

1) Power Electronics, P. C. Sen, Tata McGraw Hill. rd
2) Power Electronics Circuits, Devices & Applications, 3 edition, M. H. Rashid, Pearson

Education
3) A Textbook of Electrical Technology, Vol-II, B. L. Thareja and A. K. Thareja, S. Chand.

# RESEARCH METHODOLOGY

## DSE (Electronics) Sem VI
## (For Physics and Electronics as core subjects )

| Course Title & Code | Credits | Credit distribution of the course | | | Eligibility Criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | | |
| Research Methodology<br><br>PHYSICS DSE 13 | **4** | **3** | **0** | **1** | Class XII pass with Physics and Mathematics as main subjects | Basic ICT related skills |

### LEARNING OBJECTIVES

This course has been designed to explore the basic dimensions of research and to impart quantitative and qualitative knowledge for conducting meaningful research. Starting from the philosophy of research, through awareness about the publication ethics and misconducts, this course covers all the methodological and conceptual issues required for a successful conduct of research. It gives an overview of research techniques, data management and analysis, and commonly used statistical methods in physical sciences.

### LEARNING OUTCOMES

After successful completion of this course, students will be trained in the following. ● Skills to review literature and frame research problem
● Comprehend the relevance of the tools for data collection and analysis
● Writing a scientific report/research proposal

● Software tools for research in physical sciences ● Research integrity and publication ethics
● Importance of intellectual property rights
● Role of funding agencies in research

## SYLLABUS OF Physics DSE - 13

## THEORY COMPONENT

**Unit - I - Introduction to research methodology (6 Hours)**

Brief history of scientific method and research, role and objectives of research, basic tenets of qualitative research; research problem and review of literature: identifying a research problem (philosophy and meaning of research, identification and definition of research problem, formulation of research problem, sources of prejudice and bias); literature survey (open-source and paid tools for keeping track of the literature)

**Unit - II - Data collection, analysis and interpretation (15 Hours)**

Methods of data collection: survey, interview, observation, experimentation and case study; Descriptive statistics: Measures of central tendency (mean, median, mode) and dispersion (range, standard deviation);
Inferential statistics: Hypothesis testing, Z test, T test; regression analysis (basic concepts of multiple linear regression analysis and theory of attributes); Curve fitting using linear and nonlinear regression (parameter space, gradient search method and Marquardt method); Role of simulation, calibration methods, error analysis, and background handling in experimental design

**Unit - III – Journals, Database and Research Metrics (7 Hours)**

Journals: Free, open source and paid journals, concept of peer reviewed journals, predatory and fake journals
Databases: Indexing databases; citation databases (Web of science, Scopus); experimental physics databases (astrophysics (ADS, NED, SIMBAD, VizieR), biophysics (PubMed), particle physics (INSPIRE, CDS), condensed matter physics (X-ray database))

Research Metrics: Journal impact factor, SNIP, SJR, IPP, cite score; metrics (h-index, g index, i10 index, altmetrics), variations in research metrics across various disciplines, other limitations of the research metrics and impact factors

**Unit - IV – Scientific Conduct and Publication Ethics (8 Hours)**

Current understanding of ethics; intellectual honesty and research integrity; communicating errors (erratum, correction and withdrawal); records and logs (maintaining records of samples, raw data, experimental protocols, observation logs, analysis calculations, and codes); scientific publication misconducts: plagiarism (concept, importance, methods and ways to detect and avoid plagiarism) and redundant publications (salami slicing, duplicate and overlapping publications, selective reporting and misrepresentation of data); environmental and other clearances (waste management, disposal of hazardous waste).

COPE guidelines on best practices in publication ethics

**Unit V – Scientific Writing and Software Tools (5 Hours)**

Writing a research paper and report: introduction, motivation, scientific problem, its methodology, any experimental set up, data analysis, discussion of results, conclusions Referencing formats (APA, MLA) and bibliography management Graphical software (open source, magic plot, gnu plot, origin); presentation tools (beamer)

**Unit VI - Intellectual Property Right and Research Funding (4 Hours)**

Basic concepts and types of intellectual property (patent, copyright and trademark); Role of funding agencies in research, overview of various funding agencies (DST-SERB, UGC, CSIR, BRNS, DRDO), national and international research project grants and fellowships

**References:**

**Essential Readings:**

1) Management Research Methodology, K. N. Krishnaswamy, A. I. Sivakumar, M. Mathirajan, 2006, Pearson Education, New Delhi

2) Research Methodology, Methods and Techniques, C. R. Kothari, 2 edition, 2008, New Age International Publication. th

3) Research Methodology, A step by step guide for beginners, R. Kumar, 6 edition, 2009, Pearson Education

4) Data reduction and error analysis for the physical sciences, P. R. Bevington and D. K. Robinson, 3rd edition, McGraw-Hill

5) Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, C. J. Holland, 2007, Entrepreneur Press

**Additional Readings:**

1) Research Methods, R. Ahuja, 2001, Rawat Publications, New Delhi.

2) Research design: Qualitative, quantitative, and mixed methods approaches, J. W.

Creswell, and J. D. Creswell, 2017, Sage Publications.

3) Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, A. R. Miller and

M. H. Davis, 2000, West Group Publishers

## PRACTICAL COMPONENT

**(15 Weeks with 2 hours of laboratory session per week)**

**Students should perform at least six practicals from the following list, such that all the units mentioned below are covered.**

**Unit 1:**

1) Identify a research problem, write its brief summary and make a corresponding flowchart

2) Identify a survey-based research problem in physics and create a questionnaire to collect

data to perform meaningful research.
3) Write a literature review for a research problem.
4) Create a list of research topics (at least three) and read at least one research paper in each topic.

**Unit 2:**

1) Attend a research seminar and write a brief summary in 1000 words. Check the extent of plagiarism in this summary by using on-line plagiarism detection tools
2) Read a research paper based on the use of statistics in experimental physics and summarize its importance.
3) Collect publicly available experimental physics data. Identify the independent, dependent and control variables. Fit at least two mathematical models that can describe the data and compare their statistical significance.

**Unit 3:**

1) Review any three research papers.
a) List the major strengths and weaknesses of all of them.
b) For any one of these, create a referee report assuming you are a reviewer of the paper. Also draft a response to the referee's report assuming you are the author.
2) Review any research paper. Rewrite it as if the work has been done by you for the first time. Use two different referencing and bibliography styles

**Unit 4:**

1) Take data from any publicly available experimental physics database. Use Microsoft Office tools (such as chart/bar diagrams, equation editor etc. in Word, PowerPoint or Excel) to present, plot and infer relevant information from the data.

2) Write a scientific synopsis of a research paper using LaTeX.
3) Create a presentation using LaTeX and Beamer on any research topic
4) Select a funding agency and any two schemes or fellowships offered by them. Make a report (using LaTeX) describing the objectives, areas of research support and various components of grants offered by them.