UNIVERSITY OF DELHI

CNC-II/093/1/2024-25/307
Dated: 05.11.2024

NOTIFICATION

Sub: Amendment to Ordinance V

The following addition/ modifications are being made to Appendix-II-A to the Ordinance V of the ordinances of the University with regard to the Syllabus of BSc. Physical Science with Electronics as a core paper, under Faculty of Science based on UGCF, and are notified for information of all concerned:

(i) **Addition** - Syllabus of DSC paper titled "Physics of Devices" in Semester-V of BSc. Physical Science with Electronics as a Core paper. Details are at *Annexure-1.*

(ii) **Addition** - Syllabus of DSC paper titled "Principles and applications of Semiconductor Technology" in Semester-VI of BSc. Physical Science with Electronics as a Core paper. Details are at *Annexure-2.*

(iii) **Modification** - Revision in core paper titled "Linear and Digital Integrated Circuits" offered in 2nd Semester of BSc. Physical Science with Electronics as a Core paper. Details are at *Annexure-3.*

6/11/24

REGISTRAR

Encl. as above:

ANNEXURE-1

B. Sc. Physical Science (Electronics) Semester 5

DISCIPLINE SPECIFIC CORE COURSE – DSC-14
PHYSICS OF DEVICES

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Physics of Devices DSC – 14	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Network Analysis and Analog Electronics

LEARNING OBJECTIVES

This paper is based on advanced electronics which starts with in depth understanding of junctions through energy bands and covers the devices such as UJT, JFET, MOSFET, etc.

LEARNING OUTCOMES

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

• Develop the basic knowledge of semiconductor device physics and electronic circuits along with the practical technological considerations and applications.

• Understand the operation of devices such as UJT, JFET, MOS, various bias circuits of MOSFET, basics of CMOS and charge coupled devices.

• Learn to analyse MOSFET circuits and develop an understanding of MOSFET I-V characteristics and the allowed frequency limits.

• Apply concepts for the regulation of power supply by developing an understanding of various kinds of RC filters classified on the basis of allowed range of frequencies.

• Learn to use semiconductor diode as a clipper and clamper circuit

SYLLABUS OF DSC – 14

THEORY COMPONENT

Unit – I (5 Hours)

Intrinsic, n and p type semiconductors, effective mass, carrier concentrations-fermi level in intrinsic;

electron and hole concentrations in equilibrium, temperature dependence, introduction to direct and indirect band gap semiconductors using energy level diagram

Unit – II (8 Hours)

Barrier formation in pn junction diode, depletion width, contact potential, diode equation, tunnel diode, storage and depletion capacitances, varactor diode, metal-semiconductor contacts: Schottky junction and Ohmic junction using energy band diagram, heterojunction(qualitative, using energy level diagrams)

Unit – III (8 Hours)

Transistor as a two port network, h parameter equivalent circuit, small signal analysis of a single stage amplifier, input and output impedance, current and voltage gains; cascading transistor amplifiers, two stage RC coupled amplifier and frequency response, low, mid and high frequency range response

Unit – IV (9 Hours)

Characteristic and working of UJT, relaxation oscillator. Field Effect Transistors: JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage,Current-Voltage Output Characteristics. Introduction to metal oxide semiconductor (MOS) device/MOSFET, threshold voltage, enhancement and depletion mode MOSFETS, output and transfer characteristics. basic idea of CMOS

References:

Essential Readings:

1) Physics of Semiconductor Devices, S. M. Sze and K. K. Ng, 3rd edition 2008, John Wiley and Sons

2) Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.

3) Semiconductor Physics and Devices, D. A. Neamen, 4th edition, 2011, Tata McGraw Hill

4) Integrated Electronics, J. Millman and C. C. Halkias, 1991, Tata Mc-Graw Hill.

5) Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall.

6) Solid State Electronic Devices, B. G. Streetman and S. K. Banerjee, 7th edition

7) Introduction to Measurements and Instrumentation, A. K. Ghosh, 4th edition, 2017, PHI Learning.

PRACTICAL COMPONENT

At least five experiments to be performed from the following list.

1. To study the output and transfer characteristics of a JFET..
2. To design a dc power supply with a C filter and voltage regulator.
3. To design a single stage CE amplifier of given mid gain
4. To study the characteristics of a UJT
5. To design a simple relaxation oscillator using UJT.
6. Two stage RC coupled amplifier frequency response.
7. Study of IV characteristics of MOSFET
8. a. Study IV characteristics of CE BJT

   b. obtain h parameters from the characteristic curves

References for laboratory work:

1) Advanced PC based instrumentation; Concepts and Practice, N. Mathivanan, 2007, Prentice-Hall of India

2) Basic Electronics: A text lab manual, P. B. Zbar, A. P. Malvino, M. A. Miller,1994, Mc- Graw Hill

Annexure-2

B. Sc. Physical Science (Electronics) Semester 6

DISCIPLINE SPECIFIC CORE COURSE – DSC-17 PRINCIPLES AND APPLICATIONS OF SEMICONDUCTOR TECHNOLOGY

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Principles and Applications of Semiconductor Technology DSC – 17	**4**	**3**	**0**	**1**	Class XII pass with Physics and Mathematics as main subjects	NIL

LEARNING OBJECTIVES

a) Understand the Fundamentals of Transducers including definition of transducers and understanding their role in converting one form of energy to another. Classify different types of transducers based on their operating principles and applications.

b) Learn About Micro-Electro-Mechanical Systems (MEMS): Explain the basic principles and working of MEMS devices. Understand the fabrication processes used in MEMS technology. Explore applications of MEMS in various fields such as sensors, actuators, and biomedical devices.

c) Explore Nano-Electro-Mechanical Systems (NEMS): Understand the principles behind NEMS technology and its evolution from MEMS. Discuss the unique challenges and advantages of NEMS. Investigate the applications of NEMS in advanced technological solutions.

d) Study Sensor Technology: Explain the working principles of various types of sensors (e.g., temperature, pressure, chemical, optical). Understand sensor characteristics such as sensitivity, range, accuracy, and response time. Explore the integration of sensors in modern electronic systems and IoT applications.

e) Analyze Energy Storage Systems: Understand the principles of energy storage technologies, including batteries, supercapacitors and fuel cells. Discuss the materials and design considerations for efficient energy storage. Explore the applications of energy storage systems in portable electronics, electric vehicles, and renewable energy systems.

f) Investigate Organic Electronics: Explain the basic concepts and materials used in organic electronics, including organic semiconductors and conductive polymers. Understand the

fabrication techniques for organic electronic devices. Explore applications such as organic light-emitting diodes (OLEDs), organic solar cells, and flexible electronics.

By achieving these objectives, students will gain a comprehensive understanding of the principles and applications of transducers, MEMS & NEMS, sensors, energy storage systems, and organic electronics, equipping them with the skills needed for innovative research and development in these cutting-edge technologies

LEARNING OUTCOMES

Upon successful completion of this course the students will be able to:

a) Explain the Fundamentals of Transducers: Define transducers and describe their role in converting different forms of energy. Classify and distinguish various types of transducers based on their principles and applications.

b) Understand MEMS Technology: Explain the operating principles and fabrication processes of Micro-Electro-Mechanical Systems (MEMS). Identify and analyze applications of MEMS in sensors, actuators, and biomedical devices.

c) Explore NEMS Technology: Understand the principles and challenges associated with Nano-Electro-Mechanical Systems (NEMS). Discuss the advantages and applications of NEMS in advanced technological solutions.

d) Comprehend Sensor Technologies: Explain the working principles of various sensors, including temperature, pressure, chemical, and optical sensors. Analyze sensor characteristics such as sensitivity, range, accuracy, and response time. Integrate sensors into electronic systems and IoT applications.

e) Analyze Energy Storage Systems: Understand the principles behind different energy storage technologies, including batteries, supercapacitors, and fuel cells. Discuss the materials and design considerations for efficient energy storage solutions. Evaluate the applications of energy storage systems in portable electronics, electric vehicles, and renewable energy systems.

f) Understand Organic Electronics: Explain the basic concepts and materials used in organic electronics, including organic semiconductors and conductive polymers. Describe the

fabrication techniques for organic electronic devices. Explore applications such as organic light-emitting diodes (OLEDs), organic solar cells, and flexible electronics.

By achieving these outcomes, students will gain a comprehensive understanding and practical skills in transducers, MEMS & NEMS, sensors, energy storage systems, and organic electronics. They will be equipped to innovate and contribute to advancements in these cutting-edge technologies.

SYLLABUS OF DSC – 17

THEORY COMPONENT

Unit – 1 [14 lectures]

Basics of Transducers: Fundamentals of transducers, classification and general characteristics, displacement transducers, strain gauges, pressure and force transducers, transducers for biomedical applications (pulse / heart rate).

Basics of MEMS and NEMS: Introduction to design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of MEMS (e.g. Micro-Cantilevers) and NEMS (e.g. Switches)

Unit – 2 [10 lectures]

Basics of Sensors: Difference between sensor, transmitter and transducer - Primary measuring elements - selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy. Classification of sensors: Physical, Chemical and Biological. Types of sensors: resistive, capacitive, inductive, electromagnetic, thermoelectric, piezoelectric, piezoresistive, photosensitive and electrochemical sensors

Unit - 3 **[7 lectures]**

Basics of Energy Storage: Electrochemical energy storage devices - EMF, reversible and irreversible cells, free energy, thermodynamic calculations of the capacity of a battery. Types of batteries - Primary (Non-Rechargeable) Batteries: Alkaline Batteries, Zinc-Carbon Batteries, Lithium Batteries, Silver Oxide Batteries. Secondary (Rechargeable) Batteries: Lead-Acid Batteries, Nickel-Cadmium (NiCd) Batteries, Nickel-Metal Hydride (NiMH) Batteries, Lithium-Ion (Li-ion) Batteries, Lithium Polymer (LiPo) Batteries, Sodium-Sulfur (NaS) Batteries

Unit - 4 **[14 lectures]**

Basics of Organic Electronics: Need for organic materials in the semiconductor industry

Structure of Conducting Polymers, π-Conjugation and doping, conformational changes, Types of Conducting Polymers – Polyacetylene (PA), Polypyrrole (PPy), Polyaniline (PANI)

Structure of an OLED, Hole Injection Layer (HIL), Hole Transport Layer (HTL), Emissive Layer (EML), Electron Transport Layer (ETL), Electron Injection Layer (EIL), Working Principle, Charge Injection, Charge Transport, Recombination, Light Emission

Introduction to Silicon based solar cells, thin film solar cells, Dye sensitized solar cell, Organic solar cell: Structure of an Organic Solar Cell, Substrate, Anode, Hole Transport Layer (HTL), Photoactive Layer, Donor and acceptor Material, Bulk hetero junction devices, Light Absorption, Exciton Diffusion, Charge Separation, Charge Transport, Charge Collection

PRACTICAL COMPONENT – 30 Hours

(Any 6 to be performed)

1. Study of High Precision Resistance Strain Gauge characteristics.
2. Study of Force Sensor characteristics.
3. Study of Piezoresistive Sensor characteristics.
4. Study of Piezoelectric Sensor characteristics.
5. Study of Pulse Sensor / Heart Rate Sensor characteristics.
6. Study of gas sensor characteristics.
7. Study of solar cell characteristics.
8. Study of photodiode characteristics.
9. Study of LIDAR characteristics

Texts/References:

1. Suganuma Katsuaki, Introduction to Printed Electronics, Springer, 2014.
2. Stergios Logothetidis, Handbook of Flexible Organic Electronics - Materials,Manufacturing, and Applications, 1st Ed., Woodhead Publishing, 2014.
3. Eugenio Cantatore, Applications of Organic and Printed Electronics: A Technology Enabled Revolution, Springer, 2012.
4. Wolfgang Brütting and Chihaya Adachi, Physics of Organic Semiconductors, 2ndEd., Wiley-VCH, 2012.
5. Anna Köhler and Heinz Bässler, Electronics Processes in Organic Semiconductors -An Introduction, 1st Ed., Wiley-VCH, 2015.
6. Wenping Hu, Organic Optoelectronics, 1st Ed., Wiley-VCH, 2013.
7. Sam-Shajing Sun and Larry R. Dalton, Introduction to Organic Electronic and Optoelectronic Materials and Devices, 2nd Ed., CRC Press, 2015.
8. Franky So, Organic Electronics: Materials, Processing, Devices, and Applications, CRC Press, 2010.

B. Sc. Physical Science (Electronics) Semester 2

DISCIPLINE SPECIFIC CORE COURSE – DSC-5
LINEAR AND DIGITAL INTEGRATED CIRCUITS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Linear and Digital Integrated Circuits DSC – 5	**4**	**2**	**0**	**2**	Class XII pass with Physics and Mathematics as main subjects	NIL

LEARNING OBJECTIVES

This paper aims to provide the basic knowledge of linear and digital electronics. It discusses about the operational amplifier and its applications. Boolean algebra and combinational logic circuits are also discussed.

LEARNING OUTCOMES

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

• To understand Op-Amp basics and its various applications.

• To become familiar with logic gates and boolean algebra theorems.

• To understand the minimization techniques for designing a simplified logic circuit.

• To design a half adder, full adder, half-subtractor, and full-subtractor.

• To understand the working of data processing circuits, multiplexers, de-multiplexers, decoders and encoders.

• To become familiar with the working of flip-flop circuits, its working and applications.

SYLLABUS OF DSC – 5

THEORY COMPONENT

Unit 1: **(8 Hours)**

Operational Amplifiers (Black box approach): Characteristics of an ideal and practical Operational Amplifier (IC 741), Open and closed loop configuration, CMRR, Slew Rate and the concept of Virtual Ground.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Summing and Difference Amplifier, (3) Differentiator, (4) Integrator, (5) Wein bridge oscillator, (6) Comparator, and (7) Active low pass and high pass Butter worth filter (1st order only).

Unit 2: **(7 Hours)**

Number system: Binary number, Decimal to Binary and Binary to Decimal conversion, BCD, Octal and Hexadecimal numbers.

Logic Gates and Boolean algebra: Truth Tables of OR, AND, NOT, NOR, NAND, XOR,XNOR, Basic postulates and fundamental theorems of Boolean algebra.

Combinational Logic Analysis and Design: Standard representation of logic functions (SOP), Minimization Techniques (Karnaugh map minimization up to 4 variables for SOP).

Unit 3: **(6 Hours)**

Arithmetic Circuits: Half and Full Adder, Half and Full Subtractor, 4-bit binaryAdder/Subtractor

Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders.

Unit 4: **(5 Hours)**

Sequential Circuits: SR, D, and JK Flip-Flops. Race-around conditions in JK Flip-Flop.Master-slave JK Flip-Flop.

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel in-Parallel-out Shift Registers (only up to 4 bits).

Unit 5: (4 Hours)

Counters (4 bits): Asynchronous counter, Synchronous Counter, Decade Counter and RingCounter

D-A and A-D Conversion: 4 bit binary weighted and R-2R D-A converters, A-D conversion characteristics.

References:

Essential Readings:

1) Op-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall

2) Operational Amplifiers and Linear ICs, David A. Bell, 3rd Edition, 2011, Oxford University Press.

3) Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 8th Ed., 2018,Tata McGraw

4) Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill

5) Digital Fundamentals, Thomas L. Flyod, Pearson Education Asia (1994).

6) Digital Principles, R. L. Tokheim, Schaum's outline series, Tata McGraw- Hill (1994).

PRACTICAL COMPONENT – 60 Hours

Every student should perform at least 04 experiments each from section A, B and C

Section A: Op-Amp. Circuits (Hardware design)

1) To design an inverting and non-inverting amplifier using Op-amp (741,351) for dc voltage of given gain.

2) To design inverting and non-inverting amplifier using Op-amp (741,351) and study their frequency responses

3) To add two dc voltages using Op-Amp in inverting and non-inverting mode.

4) To design a precision Differential amplifier of given I/O specification using Op-amplifier.

5) To investigate the use of an op-amp as an Integrator.

6) To investigate the use of an op-amp as a Differentiator.

7) To design a Wien bridge oscillator for given frequency using an Op-Amplifier.

8) Design a Butter-worth Low Pass active Filter (1st order) and study frequency response.

9) Design a Butter-worth High Pass active Filter (1st order) and study frequency response.

10) Design a digital to analog converter (DAC) of given specifications.

Section B: Digital circuits (Hardware design)

1) (a) To design a combinational logic system for a specified Truth Table.

(b) To convert Boolean expression into logic circuit & design it using logic gate ICs.

(c) To minimize a given logic circuit.

2) Half Adder and Full Adder.

3) Half Subtractor and Full Subtractor.

4) 4 bit binary adder and adder-subtractor using Full adder IC.

5) To design a seven segment decoder.

6) To build Flip-Flop (RS, D-type and JK) circuits using NAND gates.

7) To build JK Master-slave flip-flop using Flip-Flop ICs.

8) To build a Counter using D-type/JK Flip-Flop ICs and study timing diagram.

9) To make a Shift Register (serial-in and serial-out) using D-type/JK Flip-Flop ICs.

Section C: SPICE/MULTISIM simulations for electronic circuits and devices

1) To verify the Thevenin and Norton Theorems.

2) Design and analyze the series and parallel LCR circuits.

3) Design the inverting and non-inverting amplifier using an Op-Amp of given gain.

4) Design and Verification of op-amp as integrator and differentiator.

5) Design the 1st order active low pass and high pass filters of given cutoff frequency.

6) Design a Wein`s Bridge oscillator of given frequency.

7) Design clocked SR and JK Flip-Flop`s using NAND Gates.

8) Design 4-bit asynchronous counter using Flip-Flop ICs.

References (For Laboratory Work):

1) Fundamentals of Digital Circuits, Anand Kumar, 4th Edn, 2018, PHI Learning.

2) Digital Computer Electronics, A. P. Malvino, J.A. Brown, 3rd Edition, 2018, TataMcGraw Hill Education.

3) Digital Electronics, S. K. Mandal, 2010, 1st edition, Tata McGraw Hill.