Max. Marks: **25+75**	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		
Unit	**Topics**	**No. of Lectures**
Part A: Introduction to Solid State Physics		
I	**Crystal Structure:** Lattice, Basis & Crystal structure. Lattice translation vectors, Primitive & non-primitive cells. Symmetry operations, Point group & Space group. 2D & 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - HCP & FCC, Diamond, Cubic Zinc Sulphide, Sodium Chloride, Cesium Chloride and Glasses.	7
II	**Crystal Diffraction:** X-ray diffraction and Bragg's law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct & Reciprocal lattice. Diffraction conditions, Ewald's method and Brillouin zones. Reciprocal lattice to SC, BCC & FCC lattices. Atomic Form factor and Crystal Structure factor.	7
III	**Crystal Bindings:** Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals (Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (van der Waals-London) & Repulsive interaction, Equilibrium lattice constant, Cohesive energy and Compressibility & Bulk modulus. Ionic crystals, Cohesive energy, Madelung energy and evaluation of Madelung constant.	7
IV	**Lattice Vibrations and Free Electron Theory:** Lattice Vibrations: Lattice vibrations for linear mono & di atomic chains, Dispersion relations and Acoustical & Optical branches (qualitative treatment). Qualitative description of Phonons in solids. Lattice heat capacity, Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, Paramagnetic susceptibility of conduction electrons and Hall effect in metals. Band Theory: Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effective mass of an electron & Concept of Holes & Classification of solids on the basis of band theory.	9
PART B: Introduction to Nuclear Physics		
V	**Nuclear Forces & Radioactive Decays:** General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and basic idea of electric quadrupole moment tensor. Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties. Radioactive Decays: Nuclear stability, basic ideas about beta minus decay, beta plus decay, alpha decay, gamma decay & electron capture, fundamental laws of radioactive disintegration and radioactive series.	9
VI	**Nuclear Models & Nuclear Reactions:** Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Introduction of Single particle shell model and magic numbers.	9

	Nuclear Reactions: Bethe's notation, types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactor and nuclear fusion.	
VII	**Accelerators & Detectors:** Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron. Detectors: Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber.	6
VIII	**Elementary Particles:** Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsic-spin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin & strangeness. Concept of Quark model.	6

Suggested Readings:

PART A

1. Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2012, 8e
2. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
3. A.J. Dekker, "Solid State Physics", Macmillan India Limited, 1993
4. R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015

PART B

5. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
6. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
7. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
8. S.N. Ghoshal, "Nuclear Physics", S. Chand Publishing, 2019

Local Author's Books

9. Atomic and Nuclear Physics, Brij Lal, S. Chand Publication.
10. Nuclear Physics, S.N. Ghoshal, S. Chand Publication.
11. Atomic and Molecular Physics, Agarwal, Jain & Sharma, Krishna Prakashan.

Suggestive Digital Platforms / Web Links:

12. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
13. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
14. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
15. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/ Assignment	**(05 marks)**
Class Test-I	**(10 marks)**
Class Test-II	**(10 marks)**

- This course can be opted as an Elective by the students of Chemistry / Computer Science / Mathematics / Statistics
- **PREREQUISITE:** Passed Semester V, Theory Paper-2 (B010502T)

Programme Class: **Degree**	Year: **Third**	Semester: **Sixth**
Subject: **PHYSICS**		
Course Code: **(B010602T)**	Course title: **Analog & Digital Principles & Applications**	
Course Outcomes: 1. Study the drift and diffusion of charge carriers in a semiconductor. 2. Understand the Two-Port model of a transistor. 3. Study the working, properties and uses of FETs. 4. Comprehend the design and operations of SCRs and UJTs. 5. Understand various number systems and binary codes. 6. Familiarize with binary arithmetic. 7. Study the working and properties of various logic gates. 8. Comprehend the design of combinational and sequential circuits.		
Credits: **4**	Core Compulsory / Elective	
Max. Marks: **25+75**	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		
Unit	**Topics**	**No. of Lectures**
Part A: Analog Electronic Circuits		
I	**Semiconductor Junction:** Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors. Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction.	9
II	**Transistor Modeling:** Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power).	8
III	**Field Effect Transistors:** JFET: Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut-Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain Resistance, Mutual Conductance or Transconductance & Amplification Factor); Biasing w.r.t. CS	8

	configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs). MOSFET: Construction and Working of D-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of D-MOSFET and E-MOSFET; Comparison of JFET and MOSFET.	
IV	**Other Devices:** SCR: Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; Applications (Static switch, Phase control system & Battery charger). UJT: Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators).	5
PART B: Digital Electronics		
V	**Number System:** Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation.	6
VI	**Binary Arithmetic:** Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division.	5
VII	**Logic Gates:** Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EX-NOR gates as pairty checker. Boolean Algebra. Karnaugh Map.	9
VIII	**Combinational & Sequential Circuits:** Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders. Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters.	10

Suggested Readings:

PART A

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

PART B

1. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
2. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
3. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

Suggestive Digital Platforms / Web Links:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/ Assignment	**(05 marks)**
Class Test-I	**(10 marks)**
Class Test-II	**(10 marks)**

- The course is elective and open to all.
- **PREREQUISITE:** Passed Semester IV, Theory Paper-1 (B010401T)

Programme Class: **Degree**	Year: **Third**	Semester: **Sixth**
Subject: **PHYSICS**		
Course Code: **(B010603P)**	Course Title: **Analog & Digital Circuits**	

Course Outcomes:

Analog & digital circuits have the most striking impact on the industry wherever the electronics instruments are used to study and determine the electronic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 2	Core Compulsory / Elective
Max. Marks: **25+75**	Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-**0-4**	

Unit	Topics	No. of Lectures
	Lab Experiment List	
	1. Energy band gap of semiconductor by reverse saturation current method 2. Energy band gap of semiconductor by four probe method 3. Hybrid parameters of transistor 4. Characteristics of FET, MOSFET, SCR, UJT 5. FET Conventional Amplifier 6. FET as VVR and VCA 7. Study and Verification of AND gate using TTL IC 7408 8. Study and Verification of OR gate using TTL IC 7432 9. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400 10. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402 11. Study and Verification of NOT gate using TTL IC 7404 12. Study and Verification of Ex-OR gate using TTL IC 7486	60
	Online Virtual Lab Experiment List/Link	
	Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/ssd/# 1. ID-VD characteristics of Junction Field Effect Transistor (JFET) 2. Silicon Controlled Rectifier (SCR) characteristics 3. Unijunction Transistor (UJT) and relaxation oscillator Virtual Labs an initiative of MHRD Govt. of India https://de-iitr.vlabs.ac.in/List%20of%20experiments.html 4. Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates 5. Construction of half and full adder using XOR and NAND gates and verification of its operation 6. To study and verify half and full subtractor 7. Realization of logic functions with the help of Universal Gates (NAND, NOR) 8. Construction of a NOR gate latch and verification of its operation 9. Verify the truth table of RS, JK, T and D Flip Flops using NAND and NOR gates 10. Design and Verify the 4-Bit Serial In - Parallel Out Shift Registers 11. Implementation and verification of decoder or demultiplexer and encoder using logic gates 12. Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates 13. Design and verify the 4-Bit Synchronous or Asynchronous Counter using JK Flip Flop 14. Verify Binary to Gray and Gray to Binary conversion using NAND gates only	

	15. Verify the truth table of 1-Bit and 2-Bit comparator using logic gates	

Suggested Readings:

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e
6. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
7. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
8. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

Suggestive Digital Platforms / Web Links:

1. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/ssd/#
2. Virtual Labs an initiative of MHRD Govt. of India, https://de-iitr.vlabs.ac.in/List%20of%20experiments.html
3. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Record File	**(15 marks)**
Viva Voce	**(05 marks)**
Class Interaction	**(10 marks)**

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics
- **PREREQUISITE:** Opted / Passed Semester VI, Theory Paper-2 (B010602T)

Further Suggestions:

- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- The institution may suggest a minimum number of experiments (say 3) to be performed by each student per semester from the Online Virtual Lab Experiment List / Link.

Important Note: The members of the Board of Studies suggested that there should be some more additional core elective courses/papers in fifth and sixth semesters, whose detailed syllabi may be developed before the start of third year of B.Sc. (Physics).