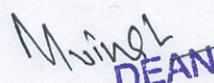




**Maharaja Surajmal Brij University**  
**Bharatpur (Rajasthan)**  
**Syllabus of Physics**  
**Under Graduate Program under NEP-2020**  
**(V&VI Semester)**  
**Academic Session (2025-26)**

M. Singh  
(Dr. M.K. Singh)  
DEAN  
FACULTY OF SCIENCE  
MSBU, BHARATPUR

SEMESTER-WISE PAPER TITLES WITH DETAILS								
B.Sc. (Math Group)								
	Level	Sem.	Type	PHYSICS Title	Credits			Total
					L	T	P	
1.	5	I	MJR	PHY-20T-101 Mechanics & Oscillations	4	0	0	4
2.	5	I	MJR	PHY-20P-102 Physics Lab-I	0	0	2	2
3.	5	II	MJR	PHY-20T-201 Electromagnetism	4	0	0	4
4.	5	II	MJR	PHY-20P-202 Physics Lab-II	0	0	2	2
5.	6	III	MJR	PHY-20T-301 Optics	4	0	0	4
6.	6	III	MJR	PHY-20P-302 Physics Lab-III	0	0	2	2
7.	6	IV	MJR	PHY-20T-401 Thermodynamics & Statistical Physics	4	0	0	4
8.	6	IV	MJR	PHY-20P-402 Physics Lab-IV	0	0	2	2
9.	7	V	MJR	PHY-20T-501 Electronics and Solid-State Devices	4	0	0	4
10.	7	V	MJR	PHY-20P-502 Physics Lab-V	0	0	2	2
11.	7	VI	MJR	PHY-20T-601 Quantum Mechanics and Spectroscopy	4	0	0	4
12.	7	VI	MJR	PHY-20P-602 Physics Lab-VI	0	0	2	2

  
**DEAN**  
 FACULTY OF SCIENCE  
 MSBU, BHARATPUR

PHY-20T-501 -Electronics and Solid State Devices

Semester	Code of the Course	Title of the Course/Paper	NITEEQF Level	Credits
V	PHY-20T-501	Electronics and Solid State Devices	6	4
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major/Minor	Lecture, Sixty Lectures including diagnostic and formative assessments during lecture hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course:	The syllabus for Electronics and Solid-State Devices aims to equip undergraduate students with a comprehensive understanding of circuit analysis, semiconductor device operation, and digital logic. It covers DC and AC circuits, semiconductor characteristics, BJTs and FETs configurations, and biasing techniques essential for amplifier and oscillator design. Students will also explore operational amplifiers and the foundational principles of Boolean algebra and logic gates. The course prepares students for practical applications and theoretical analysis in modern electronics.			

Unit 1

Circuit Analysis:

- **Electric Networks:** Definitions, loop and nodal equations for D.C. and A.C. circuits (Kirchhoff's Laws).
- **Four-Terminal Electric Network:** Ampere-volt conventions, open, closed, and hybrid parameters of four-terminal networks; input, output, and mutual impedance for active four-terminal networks.
- **Circuit Theorems:** Superposition, Thevenin, Norton, reciprocity, compensation, maximum power transfer, and Miller theorems.

*M. Vinod*  
 DEAN  
 FACULTY OF SCIENCE  
 MSBU, BHARATPUR

*3/11/2020*

**P-N Junction:** Charge densities in N and P Semiconductors; conduction by drift and diffusion of charge carriers; P-N diode equation; capacitance effects.

**Rectifiers:** Half-wave, full-wave, and bridge rectifiers; Ripple factor, efficiency, Peak Inverse Voltage and regulation; Series inductor, shunt capacitor, L-section, and  $\pi$ -section filters.

**Voltage Regulation:** Zener diode, Voltage regulation using Zener diodes; voltage multipliers.

## Unit 2

**Transistor Fundamentals:** Notations, Configurations: CB, CE, CC. operation and characteristic curves for bipolar junction transistors (BJTs); Concept of load line and operating point, hybrid parameters.

**Transistor Biasing:** Need for biasing and stability of Q point, stability factors; Types of bias circuits for thermal bias stability: fixed bias, collector-to-base feedback bias, and four-resistor bias.

**Field Effect Transistors (FETs):** Introduction and merits demerits over BJT, biasing, and volt-ampere characteristics; Source follower, operation of FET as a variable voltage resistor.

## Unit 3

**Amplifiers:** Analysis of transistor amplifiers using hybrid parameters, gain-frequency response; Cascade amplifiers, basic ideas of direct-coupled and R-C coupled amplifiers and analysis. differential amplifiers.

**Amplifiers with feedback:** Concept of feedback, positive and negative feedback, voltage and current feedback circuits, Advantages of negative feedback

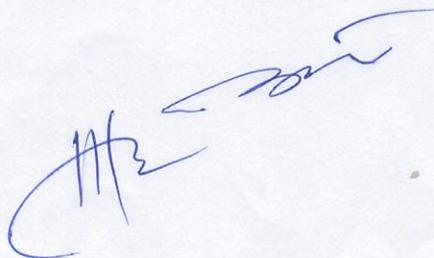
**Operational Amplifier:** Definition and history of operational amplifiers, Ideal Op-Amps. Input offset voltage and current, Common-mode rejection ratio (CMRR), Power supply rejection ratio (PSRR), Input and output impedance, Open-loop gain and frequency response, Slew rate; Inverting Amplifier, Non-Inverting Amplifier, Voltage Follower (Buffer)

## Unit 4

**Oscillators:** Criteria for self-excited and self-sustained oscillation. Circuit conditions for self-excited oscillations; Basic transistor oscillator circuit and its analysis; Colpitts's and Hartley oscillators, R.C. oscillators, crystal oscillators and their advantages.

Mishra  
DEAN  
FACULTY OF SCIENCE  
MSBU, BHARATPUR

30



**Logic Operations:** Fundamentals of Boolean Algebra, Boolean variables and functions, De Morgan's Theorems, basic logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR), symbols, truth tables, Boolean expressions, Diode-Transistor Logic (DTL) concept and configuration, Transistor-Transistor Logic (TTL) concept and evolution from DTL.

**Textbooks:**

1. Basic Electronics and Linear Circuits by N.N. Bhargava, D.C. Kulshreshtha; S.C Gupta.
2. Solid State Electronic Devices" by Ben G. Streetman and Sanjay Kumar Banerjee
3. Introduction to Semiconductor Devices" by M.S. Tyagi

**Reference books:**

1. Electronic Principles" by Albert Malvino and David Bates
2. Semiconductor Physics and Devices" by Donald A. Neamen
3. Integrated Electronics: Analog and Digital Circuits and Systems" by Jacob Millman and Christos C. Halkias
4. "Electronic Devices" by Thomas L. Floyd
5. Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky

**E-Resources:**

1. NPTEL (National Programme on Technology Enhanced Learning):  
Website: <https://nptel.ac.in/courses>
2. MIT Open Course Ware:  
Website: <https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/>;  
[https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/video\\_galleries/video-lectures/](https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/video_galleries/video-lectures/)
3. Coursera:  
Website: [Coursera - Electronics Courses](https://www.coursera.org/electronics)

*M. Singh*  
**DEAN**  
**FACULTY OF SCIENCE**  
**MSBU, BHARATPUR**

*31* *HR*

4. edX: Electronics Courses

Website: <https://www.edx.org/learn/electronics>

5. IEEE Xplore Digital Library:

Website: [IEEE Xplore Digital Library](https://www.ieee.org/xplore)

**Learning Outcomes:**

1. Understand and apply Kirchhoff's laws for analyzing DC and AC circuits.
2. Analyze four-terminal networks and calculate open, short-circuited, and hybrid parameters.
3. Apply circuit theorems like Superposition, Thevenin, and Norton to simplify circuits.
4. Comprehend the behavior of P-N junctions and their application in rectifiers and voltage regulation.
5. Explain the operation and characteristics of BJTs and FETs, including biasing techniques.
6. Design and analyze transistor amplifiers and understand feedback in amplifiers.
7. Utilize operational amplifiers in various configurations and understand practical limitations.
8. Design oscillators and understand the conditions for sustained oscillations.
9. Understand Boolean algebra and logic gates, and apply them in digital logic circuits.

M. Singh  
DEAN  
FACULTY OF SCIENCE  
MSBU, BHARATPUR

in H2

Type	Paper code and Nomenclature	Duration of Examination	Maximum Marks (Midterm+EoSE)	Minimum Marks (Midterm+EOSE)
Theory	PHY-20T-501	1 Hrs-MT/IA 3 Hrs-EoSE	20 Marks-MT/IA 60 Marks -EoSE	8 Marks-MT/IA 24 Marks -EoSE
Practical	PHY-20P-502	2 Hrs-MT/IA 3 Hrs-EoSE	10 Marks-MT/IA 40 Marks -EoSE	4 Marks-MT/IA 16 Marks -EoSE

Syllabus

PHY-20P-502 =PHYSICS LAB-V

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
V	PHY-20P-502	Physics Lab-V	6	2
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major/Minor	Practical, Sixty hours(4 hours per week) of practical including diagnostic and formative assessment during practical hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course:	The objectives of the practical in the Electronics and Solid-State Devices syllabus aim to provide hands-on experience and deepen understanding of key electronics concepts. Students will verify Kirchhoff's laws and the maximum power transfer theorem, explore the characteristics of semiconductor devices such as transistors, junction diodes, Zener diodes, and FETs, and determine the band gap in semiconductors. Practical exercises will include the analysis of temperature dependence of resistance, designing single-stage transistor audio amplifiers, amplifiers with negative feedback, and studying power supply circuits, rectifiers with various filters, and Zener regulated power supplies. Advanced experiments will cover designing oscillators like Hartley and Colpitts oscillators, investigating			

**DEAN**  
FACULTY OF SCIENCE  
MSBU, BHARATPUR

*[Handwritten signatures]*

	clipping and clamping circuits, and studying logic gates using discrete components compared with TTL integrated circuits. These practical prepare students to design, analyze, and troubleshoot various electronic circuits for further studies and professional work in electronics.
--	---

#### Exam Scheme-

Students will have to perform one practical in the exam. The duration of practical exam will be 3 hours.

#### Marks distribution

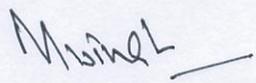
Student category	Experiments	Viva-voice	Record	Maximum marks
Regular Student	20	10	10	40

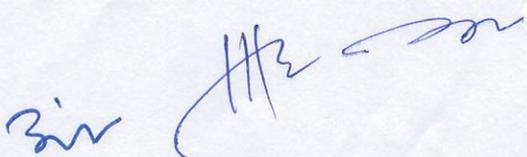
#### Marking distribution in practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	3	2	6	5	3	1

#### List of Practical:

1. Verify Kirchoff's laws using breadboard circuits with resistors and voltage sources.
2. Verify the maximum power transfer theorem.
3. Study the characteristics of a given transistor (PNP/NPN) in common emitter, common base, and common collector configurations.
4. Determine the band gap of a semiconductor using a junction diode.
5. Study the variation of gain with frequency in a single-stage transistor audio amplifier.
6. Study the temperature dependence of resistance in a semiconductor using the four-probe method.

  
**DEAN**  
**FACULTY OF SCIENCE**  
**MSBU, BHARATPUR**



7. Study the characteristics of a junction diode and a Zener diode.
8. Study the characteristics of a field effect transistor (FET) and design an amplifier with finite gain.
9. Study a power supply using full wave rectifier or a bridge wave rectifier with various filter circuits.
10. Study a half wave rectifier with L and  $\pi$  section filters.
11. Design a Zener regulated power supply and study the regulation with various loads.
12. Study the frequency response of a transistor amplifier and obtain the input and output impedance.
13. Design and study an R-C phase shift oscillator and measure the output impedance (frequency response with change of R and C components).
14. Study a voltage multiplier circuit to generate high voltage D.C. from A.C.
15. Study OR, AND, and NOT logic gates using discrete components and compare them with TTL integrated circuits (ICs).
16. Design a Hartley oscillator and study its frequency stability and waveform.
17. Design a Colpitts oscillator and study its frequency stability and waveform.
18. Investigate the effect of negative feedback on amplifier performance.

**Reference books:**

1. "Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky
2. "Microelectronic Circuits" by Adel S. Sedra and Kenneth C. Smith
3. "Solid State Electronic Devices" by Ben G. Streetman and Sanjay Kumar Banerjee
4. "The Art of Electronics" by Paul Horowitz and Winfield Hill
5. "Electronic Principles" by Albert Malvino and David Bates
6. "Electronic Devices and Circuits" by David A. Bell
7. "Basic Electronics for Scientists and Engineers" by Dennis L. Eggleston
8. "Foundations of Analog and Digital Electronic Circuits" by Anant Agarwal and Jeffrey H. Lang,
9. "Electronic Instrumentation and Measurements" by David A. Bell
10. "Operational Amplifiers and Linear Integrated Circuits" by Robert F. Coughlin and Frederick F. Driscoll

*Mishra*  
**DEAN**  
**FACULTY OF SCIENCE**  
**MSBU, BHARATPUR**

*31*

*[Handwritten signature]*

### Learning Outcomes:

Upon completion, students will be able to verify Kirchlhoff's laws and the maximum power transfer theorem. They will analyze transistor characteristics in various configurations, determine semiconductor band gaps, and study the variation of amplifier gain with frequency. Students will measure temperature-dependent resistance, understand diode and FET characteristics, design power supplies and rectifiers, explore oscillator designs and voltage multipliers, and investigate the impact of negative feedback on amplifiers, effectively bridging theoretical concepts with practical skills.

### Syllabus

#### VI-Semester

PHY-20T-601 –Quantum Mechanics and Spectroscopy

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
VI	PHY-20T-601	Quantum Mechanics and Spectroscopy	6	4
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major/Minor	Lecture, Sixty Lectures( 4 hour per week) including diagnostic and formative assessments during lecture hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			

*M. Singh*  
DEAN  
FACULTY OF SCIENCE  
MSBU, BHARATPUR

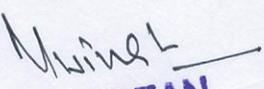
*3/11* *20/11*

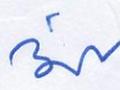
<p>Objectives of the Course:</p>	<p>This course aims to introduce the basic features of quantum mechanics and its applications in various physical phenomena. It will help students explore the core concepts, experiments, and the mathematical framework of quantum mechanics.</p> <ul style="list-style-type: none"> <li>• A central theme of the course is the Schrödinger wave equation, which explains the behavior of quantum systems.</li> <li>• Students will learn how to solve the Schrödinger wave equation for various types of potential, as well as for the hydrogen atom.</li> <li>• They will also learn about the concept of orbital angular momentum and its quantization.</li> <li>• The final section introduces students to rotational and vibrational energy levels and spectra.</li> </ul>
----------------------------------	---

### Unit - I: Evolution of quantum physics

1. Difficulties of classical mechanics to explain: the black-body emission spectrum, specific heat of solids. Plank quanta concept and radiation law, Photo electric effect and Einstein's explanations. Compton Effect, de-Broglie hypothesis, diffraction experiments for wave particles (Davisson-Germer experiment).
2. Uncertainty principle: position and momentum, angle and angular moment, energy, and time. Application of uncertainty principle: (i) Ground state energy of hydrogen atom, (ii) ground state energy of simple harmonic oscillator. (iii) Natural width of spectral lines, (iv) Non-existence of electron in nucleus.
3. Operators: linear operators. product of two operators, commuting and non-commuting operators. Simultaneous eigenfunction and eigenvalues, orthogonal wave functions, Hermitian operators, their eigenvalues. Hermitian adjoint operators, eigenvalues and eigenfunction; expectation values of operators: position, momentum, energy; Ehrenfest theorem and complementarity, Concept of group and phase velocity, wave packet, Gaussian wave packet, bra-ket notation.

(15 Lectures)

  
**DEAN**  
**FACULTY OF SCIENCE**  
**MSBU, BHARATPUR**





## Unit - II: Schrödinger wave equation and its solutions

1. Schrödinger wave equation: general equation of wave propagation, propagation of matter waves, time dependent and time-independent Schrödinger equation, wavefunction representation ( $\psi$ ), physical meaning of  $\psi$ , properties and conditions on  $\psi$ , postulates of wave mechanics, operators, observable and measurements; probability current density.
2. Time independent Schrödinger equation, stationary state solution, one dimensional problem: particle in one dimensional box, eigenfunctions and eigenvalues, discrete levels, generalization into three dimension and degeneracy of energy levels, concept of a potential well and barrier, step potential, penetration through rectangular barrier, reflection and transmission coefficients, barriers with special shapes (graphical representation), quantum mechanical tunneling effect. (alpha decay). (15 Lectures)

## Unit - III: Schrödinger equation solutions in special cases

1. Symmetric square well potential, reflection and transmission coefficients, resonant scattering, bound state problems: particle in one dimensional infinite potential well and finite depth potential well, energy eigenvalues and eigenfunctions, transcendental equation and its solution: Simple harmonic oscillator. Schrödinger equation for simple harmonic oscillator and its solution, eigenfunction, eigenvalues, zero-point energy, quantum and classical probability density, parity, symmetric and antisymmetric wave functions with graphical representation.
2. Schrödinger equation in spherical coordinates. Schrödinger equation for one electron atom in spherical coordinates, separation into radial and angular variables, solution of radial equation and angular equation, qualitative discussion of spherical harmonics, series solution and energy eigenvalues, stationary state wave function. Wave-functions of H-atom for ground and first excited states, average radius of H-atom, Bohr correspondence principle, orbital angular momentum and its quantization, commutation relation, eigenvalues and eigenfunctions (15 Lectures)

#### UNIT IV: H-atom, Atomic and Molecular spectroscopy

1. Energy level derivation for H-atom, quantum features of hydrogen spectra and hydrogen like spectra, Stern-Gerlach experiment. electron spin, spin magnetic moment. Spin-orbit coupling. Qualitative explanation of fine structure, Franck-Hertz Experiment. Zeeman effect. normal Zeeman splitting. Qualitative explanation of Stark effect.
2. Molecular spectroscopy: concept of rigid rotator, rotational energy levels, rotational spectra, selection rules, intensity of 'spectral lines, isotopic effect; Vibrational energy levels, vibrational spectra, selection rules, isotopic effect, effect of anharmonicity in vibrational spectra, vibrational-rotational spectra of CO and HCl molecules.

(15 Lectures)

#### Suggested Books and Reference-

1. Griffiths, Introduction to Quantum Mechanics, 2nd edition.
2. R. Shankar, Principles of Quantum Mechanics, 2nd edition.
3. Arthur Beiser, Perspective of modern Physics, 6th edition.
4. AK Ghatak and S Lokanathan, Quantum Mechanics: Theory and application.
5. HS Mani, GK Mehta, introduction to modern Physics.
6. C.N. Banwell and E.M. McCash. Fundamental of Molecular Spectroscopy. 4th edition.
7. H.E. White, Introduction to atomic physics,

#### Suggested E-sources:

##### Video Lectures:

MIT OpenCourseware - 8.04 Quantum Physics I <https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/>

Lecture Series on Quantum Physics by Prof.V.Balakrishnan, Department of Physics. IIT Madras.

#### Learning Outcomes for Quantum Physics Course

Upon successful completion, this course students will gain a comprehensive understanding of the fundamental principles of quantum mechanics and be able to apply them to various Problems in Solid state physics, Nuclear and particle physics, and atomic and molecular physics.

*M. Singh*  
DEAN  
FACULTY OF SCIENCE  
MSBU, BHARATPUR

**Syllabus**  
**PHY-20P-602-Physics Lab-VI**

Semester	Code of the Course	Titel of the Course/Paper	NHEQFE Level	Credits
VI	Major	Physics Lab-VI	6	2
Level of Course	Type of Course	Delivery of the Course		
Introductory	Major	Practical, Sixty hours (4 hours per week) of practical including diagnostic and formative assessment during practical hours.		
Objectives of the Course	The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies. To achieve perfectness in experimental skills and Measure fundamental constants and probe material properties in the lab.			

**Exam Scheme-**

Students will have to perform one practical in the exam. The duration of practical exam will be 3 hours.

**Marks distribution**

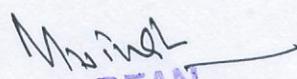
Student category	Experiments	Viva-voice	Record	Maximum marks
Regular Student	20	10	10	40

**Marking distribution in practical**

Student category	Theory/ formula	Figure/ circuit	observation	Calculation	Result/ Error	Precautions
Regular	3	2	6	5	3	1

**List of experiments**

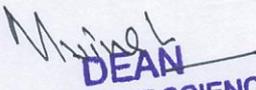
- [1] Determination of Planck's constant by photo cell (retarding potential method using: optical filters, preferably live wavelengths).
- [2] Determination of Planck's constant using solar cell.
- [3] Determination of Stefan's constant (Black body method).

  
**DEAN**  
**FACULTY OF SCIENCE**  
**MSDU, BHARATPUR**

- [4] Study of the temperature dependence of resistivity of a semiconductor using four probe-methods.
- [5] Study of Iodine spectrum with the help of grating and spectrometer and ordinary bulb light.
- [6] Study of characteristics of a GM counter and verification of inverse square law for the same strength of a radioactive source.
- [7] Study of  $\beta$ -absorption in Al foil using GM Counter to find endpoint energy.
- [8] To find the magnetic susceptibility of a paramagnetic solution using Quineke's method.
- [9] Determination of coefficient of rigidity as a function of temperature using torsional oscillator (resonance method).
- [10] Study of polarization by reflection from a glass plate with the help of Nicol's prism and photocell and verification of Brewster's Law and Malus's Law.
- [11]  $e/m$  measurement by helical method.
- [12] Measurement of magnetic field using ballistic galvanometers and search coil (using earth inductor for calibration of galvanometer). Study of variation of magnetic field of an electromagnet with current.
- [13] Measurement of electric charge by Millikan's oil drop method.

#### Learning outcomes -

This course covers a wide range of topics in physics. Upon completion, students will be able to: i. Quantify- fundamental physical constants ii. Characterize material properties iii. Analyze radiation and its interactions iv. Investigate light polarization v. Develop proficiency in handling laboratory instrumentation.

  
**DEAN**  
**FACULTY OF SCIENCE**  
**MBSU, BHARATPUR**

