KURUKSHETRA UNIVERSITY
KURUKSHETRA

(Established by the State Legislature Act XII of 1956)
("A++" Grade NAAC Accredited)

Scheme of Examination and Syllabus for

Undergraduate Programme

Subject: PHYSICS

Under Multiple Entry-Exit, Internships and

CBCS-LOCF in accordance to NEP 2020

w.e.f. 2023-24 (in phased manner)

Kurukshetra University Kurukshetra

Scheme and Syllabus of Examination for Undergraduate programme
Subject: PHYSICS
Under Multiple Entry-Exit, Internships and
CBCS-LOCF in accordance to NEP 2020
w.e.f. 2023-24 (in phased manner)

Semester	Course Type	Course Code	Nomenclature of paper	Credits	Contact hours	Internal marks	End term Marks	Total Marks	Duration of exam (Hrs) T / P
1	CC-1/ MCC-1	B23-PHY-101	Mechanics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-2	B23-PHY-102	Mathematical Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	CC-M1	B23-PHY-103	Elementary Mechanics	1	1	10	20	30	3
			Practicum	1	2	5	15	20	3
	MDC 1	B23-PHY-104	Physics Fundamentals-I	2	2	15	35	50	3
			Practicum	1	2	5	20	25	3
2	CC-2 MCC-3	B23-PHY-201	Electricity and Magnetism & EM Theory	3	3	20	50	70	3
			Practicum	1	3	10	20	30	3
	CC-M2	B23-PHY-202	Elementary Electricity, Magnetism & EM Theory	1	1	10	20	30	3
			Practicum	1	2	5	15	20	3
	DSEC-1	B23-PHY-203	Computational Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MDC- 2	B23-PHY-204	Physics Fundamentals-II	2	2	15	35	50	3
			Practicum	1	2	5	20	25	3

3	CC-3/ CC-M3/ MCC-4	B23-PHY-301	Thermodynamics & Statistical Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-2	B23-PHY-102	Mathematical Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-5	B23-PHY-303	Classical Mechanics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MDC 3	B23-PHY-304	Elements of Modern Physics	2	2	15	35	50	3
			Practicum	1	2	5	20	25	3
4	CC-4/ MCC-6	B23-PHY-401	Waves and Optics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-7	B23-PHY-402	Introductory Quantum Mechanics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-8	B23-PHY-403	Atomic Spectroscopy	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	DSE-1	B23-PHY-404	Laser Physics and Fiber Optics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
		OR							
		B23-PHY-405	Physics of Nano Materials	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
5	CC-5 MCC-9	B23-PHY-501	Modern Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-10	B23-PHY-502	Nuclear Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3

	DSE-2	B23-PHY-503	Environmental Physics	4	4	30	70	100	3
		OR							
		B23-PHY-504	Non-Linear Dynamics	4	4	30	70	100	3
	DSE-3	B23-PHY-505	Instrumentation and Analytical Methods	4	4	30	70	100	3
		OR							
		B23-PHY-506	Renewable Energy and Energy Harvesting	4	4	30	70	100	3
6	CC-6/ CC-M6/ MCC-11	B23-PHY-601	Electronics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-12	B23-PHY-602	Solid State Physics-1	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	DSE-4	B23-PHY-603	Radiation Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
		OR							
		B23-PHY-604	Thin Films and Characterization	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	DSE-5	B23-PHY-605	Numerical Methods in Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
		OR							
		B23-PHY-606	Applied Nuclear Techniques	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
7	CC-H1	B23-PHY-701	Advanced Mathematical Physics	4	4	30	70	100	3
	CC-H2	B23-PHY-702	Advanced Classical Mechanics	4	4	30	70	100	3
	CC-H3	B23-PHY-703	Quantum Mechanics-I	4	4	30	70	100	3
	DSE-6 /DSE-H1	B23-PHY-704	Electronics Devices and Circuits-I	4	4	30	70	100	3

		OR							
		B23-PHY-705	Sensors and Transducers	4	4	30	70	100	3
	PC-H1	B23-PHY-706	Practicum Course	4	8	30	70	100	4
	CC-HM1	B23-PHY-707	Basics of Laser Physics and Fiber Optics	4	4	30	70	100	3
8	CC-H4	B23-PHY-801	Quantum Mechanics-II	4	4	30	70	100	3
	CC-H5	B23-PHY-802	Nuclear and Particle Physics	4	4	30	70	100	3
	CC-H6	B23-PHY-803	Solid State Physics-II	4	4	30	70	100	3
	DSE-7 /DSE-H2	B23-PHY-804	Electronic Devices and Circuits-II	4	4	30	70	100	3
		OR							
		B23-PHY-805	Astrophysics	4	4	30	70	100	3
	PC-H2	B23-PHY-806	Practicum Course	4	8	30	70	100	4
	Research	B23-PHY-R-807	Project/ Dissertation	12			300	300	
	CC-HM2	B23-PHY-808	Nanoscience and Nanomaterials	4	4	30	70	100	3

Scheme of Examination for VAC/VOC

Semester	Course Type	Course Code	Nomenclature of paper	Credits	Contact hours	Internal marks	End term Marks	Total Marks	Duration of exam (Hrs) T / P
3	VAC-3	B23-VAC-316	Indian Astronomy in the 18^{th} and 19^{th} Centuries	2	2	15	35	50	3
3	VAC-3	B23-VAC-318	Basics of Indian Astronomy	2	2	15	35	50	3
3	VAC-3	B23-VAC-326	Exploring the Journey of Indian Space Satellites	2	2	15	35	50	3
4	VAC-4	B23-VAC-419	Physics in Everyday Life	2	2	15	35	50	3
4	VAC-4	B23-VAC-423	Radiation Hazards	2	2	15	35	50	3
5	VOC-1	B23-VOC-114	Refrigeration and Air Conditioning	2	2	15	35	50	3
			Practicum	2	4	15	35	50	3
6	VOC-3	B23-VOC-322	Maintenance of Laboratory Instruments	2	2	15	35	50	3
			Practicum	2	4	15	35	50	3
6	VOC-3	B23-VOC-323	Installation and Maintenance of Solar Panels	2	2	15	35	50	3
			Practicum	2	4	15	35	50	3

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-5/MCC-9

Session: 2023-24			
PartA - Introduction			
Subject	Physics		
Semester	5th		
Name of the Course	Modern Physics		
Course Code	B23-PHY-501		
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC/MCC		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (ifany)	Appeared or passed the 4thsem (B.Sc Physical Science or equivalent)		
CourseLearningOutcomes(CLO):	After completing this course, the learner will be able to: 1. Understand the need for Quantum Mechanics, Heisenberg's uncertainty principle, time dependent and time independent Schrodinger equation, expectation values of position and momentum, particle confined in one dimensional box. 2. Familiar about the crystalline state, basis, crystal lattices, Reciprocal lattice to sc, bcc and fcc lattices. 3. Analyze the Hydrogen atom problem based on Sommerfeld theory, Vector Atom Model, LS&JJ coupling. 4. Familiar about various Nuclear Models, Magic Numbers, Classification of fundamental particles and Strange particles. 5. Learn to present observations, results, analysis and different concepts related to experiments of Quantum Mechanics and Solid State physics.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Introductory Quantum Mechanics:** Need ofQuantum Mechanics**,**Planck's quantum hypothesis and radiation formula, quantization of EM radiation and photoelectric effect, Compton effect, de-Broglie hypothesis, de-Broglie wave,wave packet,phase and group velocities,Time-dependent and time- independent Schrodinger equations, Properties of wave function, Probability current density, linear momentum and energy operators, commutator of position and linear momentum operator, expectation values of position and linear momentum, particle confined in a one-dimensional infinite box: energy eigen functions and eigenvalues. Heisenberg's Uncertainty Principle and its applications	11
II	**Solid State Physics:** Crystalline state, crystal lattice, basis, lattice translation vectors, primitive and non-primitive unit cells, symmetry operations, Bravais lattices in two and three dimensions, Miller Indices, crystallographic planes, interplanar spacing, simple crystal structures: NaCl, CsCl,HCP, Zinc blende, Diamond, diffraction of waves by crystals, Bragg's law, Ideaof Reciprocal Lattice:Reciprocal lattice to sc,bcc and fcc lattices, non-crystalline solids (introduction only)	11
III	**Atomic and Molecular Physics:** Sommerfeld theory (qualitative), Relativistic correction, Fine structure of H_α line, Lamb shift, Larmor's theorem (qualitative), Vector Atom Model, electron spin, space quantization, spin-orbit Interaction energy, LS and JJ coupling, Spectral terms for equivalent and non-equivalent electrons, Anomalous Zeeman effect, Lande's g-factor, splitting of D1 and D2 lines in weak magnetic field, Raman effect, Stoke and Anti-stoke lines	11
IV	**Nuclear and Particle Physics:** Composition of nucleus, stability of nucleus, nuclear properties, nuclear size, spin, parity, magnetic moment, quadrupole moment, Nuclear Models, Liquid Drop Model and Semi-empirical Mass formula, Nuclear shell model and magic numbers (qualitative idea only), classification of fundamental particles, Quark and Lepton quantum numbers, Hadrons, Baryons and Mesons, Different types	12

	of interactions and their properties	
	Practicum 1. To determine the Planck's constant using photocell. 2. To determine e/m by Thomson method. 3. To determine the ionization potential of mercury. 4. To study quantization of energy using Frank Hertz experiment. 5. To determine the wavelength of laser source using diffraction of double slits. 6. To determine diameter of wire using laser source. 7. To study the variation of resistivity with temperature of given semiconductor crystal using four probe method. 8. To find the unknown capacitance of a capacitor using De-Sauty's Bridge. **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**	30
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation:**Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.:**10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 50 Marks** **: 20 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill 2. Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Pearson publishing 3. Quantum Mechanics: Theory and Applications by Ajoy Ghatak and S. Lokanathan (2019), (Extensively revised6th Edition), Laxmi Publications, New Delhi 4. Quantum Mechanics by Ishwar Singh Tyagi, Pearson publication 5. Introduction to solid state physics by C. Kittle, Wiley India 6. Solid state physics by H C Gupta, Vikas publishing house Ltd, New Delhi 7. Solid state physics by Puri & Babber, S. Chand & company, New Delhi 8. Concepts of Nuclear Physics by B L Cohen, Tata McGraw Hill Publication, 1974. 9. Nuclear Physics by D.C. Tayal, Himalaya publishing house 10. Atomic and Nuclear Physics by N. Subrahmanyam, S. Chand & company 11. Atomic & Molecular spectra by Raj Kumar, KedarNath Ram Nath, Meerut 12. Introduction to elementary particles by D. Griffiths 13. Elements ofSpectroscopyS.L.Gupta, V. Kumar and R.C.Sharma, PragatiPrakashan, Meerut.		

14. Atomic and NuclearPhysics by S.N. Ghoshal, VolI (1996), S. Chand & Com., New Delhi
15. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
16. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: MCC-10

<table>
<tr><th colspan="4">Session: 2023-24</th></tr>
<tr><th colspan="4">PartA - Introduction</th></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">5th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Nuclear Physics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-502</td></tr>
<tr><td>CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">MCC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">300-399</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Appeared or passed the 4thsem (B.Sc Physical Science or equivalent)</td></tr>
<tr><td>CourseLearningOutcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand the Nuclear structure and general properties of nuclei. Determination of Nuclear size, mass and charge. Nuclear binding energy and nuclear stability.
2. Familiar about the different types of nuclear radiation decay and their energetic. What are the processes involved during the interaction of radiations with matter.
3. Understand the principle, construction, working and applications of different nuclear accelerators. Nuclear radiation detector; Types, Principle, construction and working involved to detect the nuclear radiations.
4. Acquire knowledge of different types of nuclear reaction, conservation laws and energetic of nuclear reaction. Nuclear reactor; design, classification and uses.
5. Learn to present observations, results, analysis and different concepts related to experiments of Nuclear Physics.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>4</td></tr>
</table>

Contact Hours	3	2	5

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Nuclear structure and general Properties of Nuclei:** Constituents of Nucleus; Nuclear composition (p-e and p-n hypotheses), Nuclear properties; Nuclear size, spin, parity, statistics, magnetic dipole moment, Electric quadruple moment (shape concept). Nuclear mass and its determination by Bain-Bridge, Bain-Bridge and Jordan mass spectrograph. Nuclear charge and its determination by Moseley Law. Determination of size of nucleus by Rutherford Back Scattering. Binding energy, Average binding energy and its variation with mass number, main features of binding energy versus mass number curve, systematic of nuclear binding energy, nuclear stability, stability region.	10
II	**Nuclear Radiation decay Processes:** (a) α-decay: Basics of α-decay process and quantum mechanical explanation of α-decay. Energetics of α-decay, (b) β-decay: β^- -decay, β^+ -decay, electron capture decay, β-energy spectrum, end point energy; Origin of continuous beta spectrum (neutrino hypothesis) and energetics of beta-decay. (c) γ-decay; γ-rays emission and energetics of γ- rays. **Nuclear Radiation Interaction**: Interaction of heavy charged particles (α- particles); Energy loss of heavy charged particle (idea of Bethe formula, no derivation), Range and straggling of α-particles. Geiger-Nuttal law. Interaction of light charged particle (β-particle), Energy loss of β-particles (ionization), Range of electrons, absorption of β-particles. Interaction of γ-Ray; Passage of γ-radiations through matter (Photoelectric, Compton and pair production effect) electron-positron annihilation. Absorption of γ-rays (Mass attenuation coefficient) and its application.	12
III	**Nuclear Accelerators**: Linear accelerators: Principle, construction, theory, working and types. Tandum accelerator; Principle, construction, working, advantages and limitations. Cyclotron: Principle, construction, theory, working and its limitations. Betatron: condition, Principle, construction,	11

	theory, working and comparison with a transformer. **Nuclear Radiation Detectors**: Gas filled detectors; Ionization chamber, proportional counter, G.M. Counter (detailed study), Basic principle of organic and inorganic Scintillation detectors for γ and electron radiation, photomultiplier tube and Semiconductor Detector (Basic idea).	
IV	**Nuclear Reactions:** Nuclear reactions, Elastic and Inelastic scattering, Nuclear disintegration, photonuclear reaction, radiative capture, direct reaction, heavy ion reactions and spallation reactions, conservation laws, Q-value and reaction threshold. **Nuclear Reactors**: Nuclear Reactors, General aspects of reactor design. Nuclear fission and fusion reactors, (Principle, construction, working and applications).	11
	Practicum 1. Determination of Characteristics of GM tube and its operating voltage, plateau length and slop. 2. Verification of inverse square law of radiation for a gamma source. 3. Investigation of statistical nature of nuclear radiation using G. M. Counter. 4. To study the beta counting efficiency of G. M. Counter. 5. Investigation of variation of Linear Absorption Coefficient of beta rays using a GM counter. 6. To study the half-life of radioactive element using G. M. Counter. 7. Resolving time of G. M. Counter set-up. 8. To study the characteristics of Ionization Chamber. **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**	30
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 50 Marks** **: 20 Marks**
PartC-Learning Resources		

Recommended Books/e-resources/LMS:

1. Kaplan I, Nuclear Physics, 2nd Ed (1962), Oxford and IBH, New Delhi
2. Sriram K, Nuclear Measurement Techniques, (1986), AEWP, New Delhi
3. Tayal D C, Nuclear Physics (1994), HPH, Bombay
4. Ghoshal S N, Atomic and Nuclear Physics Vol II (1994), S Chand & Co New Delhi
5. Srivastava B N, Basic Nuclear Physics, (1993), Pragati Prakashan Meerut
6. Halliday, Introductory Nuclear Physics, Asia Publishing House, New Delhi
7. Sood D D, Ready A V R and Ramamoorthy, Fundamentals of Radiochemistry, IANCAS (2007), BARC, Bombay
8. Cohen B L, Comcepts of Nuclear Physics (1998), Tata Mc Graw Hill, New Delhi
9. Krane K S, Introductory Nuclear Physics (1988), John Wiley & Sons New Delhi
10. Patel S B, Nuclear Physics (1992), Wiley Eastern Ltd, New Delhi
11. Roy R R and Nigam B P, Nuclear Physics (1993), Wiley Eastern Ltd New Delhi.
12. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
13. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-2

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">5th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Environmental Physics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-503</td></tr>
<tr><td>CourseType:
(CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSE</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">300-399</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Appeared or passed the 4thsem (B.Sc Physical Science or equivalent)</td></tr>
<tr><td>CourseLearningOutcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Exhibit the knowledge of Basic atmospheric physics and Atmospheric thermodynamics.
2. Learn about the Environmental physics, Human environment, Air regulation in buildings, Thermal conduction effects.
3. Understand the Scope of Environmental Physics.
4. Learn about the Transport of Heat, Massand Momentum and Radiant Energy.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>4</td><td>-</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>4</td><td>-</td><td>4</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks:70</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter</u>
1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus.</td></tr>
</table>

This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Basic atmospheric physics:** Introduction to the Atmosphere, Composition and Structure: Description of Air, Stratification of Mass, Thermal and Dynamical Structure, Trace Constituent. Concept of Albedo, solar constant, Heat budget of the earth atmospheric system. **Atmospheric thermodynamics**: Air (excluding and including water), Water paths, Ideal gas law, Atmospheric composition, Hydrostatic balance, Constant vertical gradient of temperature, Conservation of energy (dry case, moist case), Entropy and potential temperature, Parcel concepts, lapse rate (dry and moist adiabatic), tephigram, Cloud formation.	14
II	**Environmental physics**: Definition, Physics in the environment: Human environment, Built environment, Urban environment, Global environment, Biological environment. **Human environment**: Introduction, Laws of Thermodynamics, Energy and metabolism, Thermodynamics laws and the human body, Second Law of Thermodynamics and the Gibbs free energy, Conduction, Convection, Radiation, Evaporation, Energy budget equation, Survival in the cold, Thermal comfort and insulation, Boundary layer, Wind chill, Hypothermia, Survival in hot climates, Effect of heat on the human body. **Built Environment:** Introduction, Thermal regulation in buildings, Thermal insulation, Thermal conduction effects, Convection effects, Radiation effects, U-values, Energy use in buildings, Air regulation in buildings, Ventilation requirements, Ventilation installations, Heat pumps, Water vapour, Humidity, Condensation in buildings.	17
III	**Scope of Environmental Physics:** Properties of Gases and Liquids-Gases and Water Vapor, Hydrostatic Equation, First Law of Thermodynamics, and Specific Heats, Latent Heat, Potential Temperature, Water Vapor and its Specification, Vapor Pressure, Dew-Point Temperature, Saturation Vapor Pressure Deficit, Mixing Ratio, Specific and Absolute Humidity, Virtual Temperature, Relative Humidity, Wet-Bulb Temperature. Liquid- Water Content and Potential, Liquid-Air Interfaces, Stable Isotopes.	14
IV	**Transport of Heat, Mass, and Momentum**: Transfer Equation, Molecular Transfer Processes, Momentum and Viscosity, Heat and Thermal Conductivity, Mass Transfer and Diffusivity, Diffusion Coefficients, Diffusion of Particles. **Transport of Radiant Energy:** Origin and Nature of Radiation-Absorption and Emission of Radiation, Full or Black Body Radiation, Wien's Law, Stefan's Law, Planck's Law, Quantum Unit, Radiative	15

	Exchange. Spatial Relations- Cosine Law for Emission and Absorption, Reflection, Radiance and Irradiance, Attenuation of a Parallel Beam.	
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**		**End Term Examination : 70 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Fundamentals of Atmospheric Physics, Murry L. Salby, Publisher Elsevier
2. An Introduction to Atmospheric Physics 2nd Edition, David G. Andrews, Cambridge University Press
3. Introduction to environmental physics: Planet Earth, Life and climate, Nigel Mason and Peter Hughes, Taylor and Francis.
4. Principles of Environmental Physics Plants, Animals, and the Atmosphere (4th Edition), John Monteith and Mike Unsworth, Elsevier
5. Exercises in Environmental Physics, Valerio Faraoni,Springer

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-2

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">5th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Non-Linear Dynamics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-504</td></tr>
<tr><td>CourseType: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSE</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">300-399</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Appeared or passed the 4thsem (B.Sc. Physical Science or equivalent)</td></tr>
<tr><td>CourseLearningOutcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand the conceptof dynamical systems.
2. Learn the concept of integrability and non-integrability of dynamical systems.
3. Understand the nonlinear Schrodinger equations, solitons and their solutions.
4. Learn the basic concepts of fluids, flow phenomenon and their dynamics.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>4</td><td>-</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>4</td><td>-</td><td>4</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks:70</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter</u>
1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set</td></tr>
</table>

from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Introduction to Nonlinearity**: Dynamical systems: Linear and nonlinear forces, Mathematical implications of nonlinearity, linear and nonlinear systems, linear superposition principle, definition of nonlinearity and its effects, Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Concept of stability and un-stability. Simple mechanical systems as first order dynamical systems: simple and damped harmonic oscillators	15
II	**Integrability**:Integrable and non-integrable dynamical systems, notion of integrability, complex integrability, symmetries and integrability: invariance condition, first integral of motion and its types, applications, A direct method to find first integral of motion	15
III	**Partial different equations & Solitons:** Linear and nonlinear differential equations, diffusive and dispersive; boundary value problems; methods of separation of variables, characteristics; inverse scattering; symbolic computation; similarity and Backlund transformations. Soliton theory: periodic, conoidal and solitary wave solutions of Korteweg-de Vries, Nonlinear Schrodinger and sine-Gordon equations; conserved densities.	15
IV	**Elementary Fluid Dynamics:**Importance of fluids: Fluids in the pure sciences, fluids in technology. Study of fluids: Theoretical approach, experimental fluid dynamics, computational fluid dynamics. Basic physics of fluids: The continuum hypothesis-concept of fluid element or fluid parcel; Definition of a fluid- shear stress; Fluid properties:-viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state; Flow phenomena- flow dimensionality, steady and unsteady flows, uniform and nonuniform flows, viscous and inviscous flows, incompressible and compressible flows, laminar and turbulent flows, rotational and irrotational flows, separated and unseparated flows.	15

SuggestedEvaluationMethods

InternalAssessment:	**End Term Examination**
➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** Mid-Term Exam: **15 Marks**	**70 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Nonlinear Dynamics: Integrability, Chaos and Pattern, M. Lakshmanan & S. Rajasekar, Springer
2. Nonlinear Dynamics and Chaos, Steven H. Strogatz, Levant Books, Kolkata, 2007
3. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
4. An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002
5. Classical and Quantum Mechanics of Noncentral Potentials: A survey of two-dimensional systems, R. S. Kaushal, Narosa Publishing House, New Delhi, 1998
6. Elementary Fluid Mechanics, Tsutomu Kambe (World Scientific, 2007)

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-3

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">5th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Instrumentation and Analytical Methods</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-505</td></tr>
<tr><td>CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSE</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">300-399</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Appeared or passed the 4thsem (B.Sc Physical Science or equivalent)</td></tr>
<tr><td>CourseLearningOutcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Have knowledge about the errors in measurements.
2. Understand the basic instrumentation of electrical and electronic measurements.
3. Understand the principles and working of basic analytical instruments – CRO, frequency signal generator and pulse generators,
4. Have awareness about the spectroscopic instruments.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>4</td><td>-</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>4</td><td>-</td><td>4</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks:70</td><td colspan="2">Time: 3hrs</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter</u>
1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus.</td></tr>
</table>

This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Basics of Measurement:** Least count of an instrument, instrument's accuracy, precision, sensitivity, resolution, significant figures, Errors in measurement-Gross errors and systematic errors, absolute errors and relative errors; Measurement error combinations-Sum of errors, difference of errors, product of errors, quotient of quantities and quantity raised to a power. **Statistical analysis of errors**: Arithmetic Mean value, deviation, standard deviation of mean, least square fitting, normal distribution, covariance and correlation, Binomial distribution, Poisson distribution and Chi square test.	15
II	**Electrical instrumentation:** AC bridges-Measurements of inductance by Maxwell's bridge, Measurement of capacitance and high resistance by De Sauty's bridge, measurement of mutual inductance by Carry Foster bridge **Signal generators:** Block diagram, explanation of low frequency signal generator, pulse generator and function generator	14
III	**Display devices:** Cathode Ray Oscilloscope: Block diagram of general purpose oscilloscope and its basic operation, Construction of CRT, electron gun,Electrostatic focusing and deflection, screen for CRT, Dual trace oscilloscopes,Front panel controls, Measurement of voltage, frequency and phase; Pulse measurements-Pulse amplitude, pulse width and space width; Display of device characteristics; Time based measurements LED: Construction and use of LED in display. Liquid crystal, types of liquid crystals. Basic principle of LCD and its construction, Comparison between LED and LCD.	16
IV	**Spectroscopic Instrumentation:** UV-visible spectrophotometer: Beer-Lambert law, absorptivity, UV and Visible absorption, Instrumentation, essential parts of spectrophotometer (double beam spectrophotometer), grating and prisms, radiant energy sources, filters, photosensitive detectors, photomultiplier tubes, relation between absorption in visible and UV region and molecular structure, applications of UV-visible spectroscopy. IR spectrophotometry: Fourier Transform Infrared (FTIR) spectrometer, Principle, working and applications.	15
SuggestedEvaluationMethods		

InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination** **70 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Theory of errors in Physical measurements by J C Pal, New Central Book Agency-2010.
2. Measurement, Instrumentation and Experimental Design in Physics and Engineering by Michael Sayer and Abhai Mansingh, PHI Learning Private Limited, Delhi, 2015.
3. Electronic Instrumentation and Measurements by David A. Bell, PHI Learning Private Limited, Delhi, 2nd edition 2010.
4. Handbook of Analytical Instruments by R.S. Khandpur, Tata McGraw-Hill, 3rd edition 2006.
5. Measurement and instrumentation Principles by Alan S Morris, Elsevier-2006.
6. Polymer characterization. Physical techniques- D. Campbell and J.R. White, Chapman and Hall.

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-3

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	5th		
Name of the Course	**Renewable Energy and Energy Harvesting**		
Course Code	B23-PHY-506		
Course Type: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)	DSE		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	Appeared or passed the 4thsem (B.Sc Physical Science or equivalent)		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the significance of renewable energy in addressing global energy challenges 2. Differentiate between various renewable energy sources and their applications 3. Analyze the environmental, social and economic implications of renewable energy adoption 4. Explain the mechanisms of renewable energy conversions.		
Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**		**Time:3hrs**	
Part B- Contents of the Course			
Instructions for Paper- Setter 1. Nine questions will be set in total. 2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus.			

This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Introduction to Renewable Energy:** Overview of renewable energy sources, Importance of renewable energy in sustainable development, Comparison between renewable and non-renewable energy sources, Basic principles of energy conversion in renewable energy systems, Environmental and economic benefits of renewable energy	15
II	**Solar Energy Harvesting:** Principles of solar energy conversion, Photovoltaic effect and solar cell technology, Types of solar panels and their efficiency, Solar thermal energy systems: principles and applications, Challenges and advancements in solar energy technology	15
III	**Wind Energy Conversion and Geothermal Energy:** Wind energy resources and distribution, Aerodynamics of wind turbine blades, Types of wind turbines and their applications, Power generation from wind energy, Wind energy integration into the electrical grid, Geothermal Energy and its sources, Geothermal power plants, its types and operation, Applications of geothermal heat pumps.	15
IV	**Biomass and Hydroelectric Energy:** Biomass as a renewable energy source, Biomass conversion technologies: combustion, gasification, and anaerobic digestion, Hydroelectric power generation: principles and types of hydroelectric plants, Environmental and social impacts of biomass and hydroelectric energy, Future trends and innovations in biomass and hydroelectric energy.	15

Suggested Evaluation Methods

InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination** **:70 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Renewable Energy: Power for a Sustainable Future by Godfrey Boyle, Oxford University Press, 3rd edition, 2012.
2. Introduction to Renewable Energy by Vaughn C. Nelson, CRC Press, 2016.
3. Renewable Energy: Sources for Fuels and Electricity by Thomas B. Johansson et al.,

Island Press, 1992.
4. Solar Engineering of Thermal Processes by John A. Duffie and William A. Beckman, John Wiley & Sons., 3rd edition, 2006.
5. Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy by Michael Boxwell, Greenstream Publishing, 2023.
6. Wind Power: Renewable Energy for Home, Farm, and Business by Paul Gipe, Chelsea Green Publishing, 2004.
7. Introduction to Wind Energy: Renewable Energy and the Environment by John Twidell and Tony D. Weir, Taylor and Francis, 1986.
8. Wind Energy Handbook by Tony Burton et al., Wiley, 2011.
9. Biomass to Renewable Energy Processes by Jay Cheng, CRC Press, 2017.
10. Fundamentals of Geophysics by William Lowrie, Cambridge University Press, 2nd edition, 2012.

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-6/MCC-11

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	6th		
Name of the Course	Electronics		
Course Code	B23-PHY-601		
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC/MCC		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (ifany)	Appeared or passed the 5thsem (B.Sc Physical Science or equivalent)		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the operation of pn junction, use of diode as Rectifier, voltage multiplier circuits, Zener Diode, Photo diode, solar cell, clipping and clamping circuits. 2. Familiar about Bipolar Junction Transistor, use of transistor as Amplifier in CB, CE and CC configurations. 3. Understand the concept of feedback in amplifiers, its types and effect of negative feedback on characteristics of amplifiers. 4. Analyze the operation of oscillators, classification of oscillators as LC oscillators, RC oscillators and crystal oscillators. 5. Learn to present observations, results, analysis and different concepts related to experiments of Electronics.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**		**Time:3hrs**	

Part B-Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Semi-Conductor Diodes:**Semiconductors: Intrinsic and Extrinsic, P-N Junction diode and its V-I characteristics, Ideal Diode, Zener and Avalanche Breakdown, Zener Diode and its application as Voltage regulator, Photo-Diode, Light Emitting Diode, Solar Cell. P-N Junction as Half Wave and Full Wave Rectifiers: Efficiency and Ripple Factor, Comparison of Rectifiers, Clipping and Clamping circuits, Voltage Multiplier Circuits: Doubler and Tripler.	11
II	**The Bipolar Transistor:** The Bipolar Junction Transistor, Transistor Action and Working (PNP and NPN transistor), Transistor Circuit configurations: Common Base (CB), Common Emitter (CE) and Common Collector (CC) configurations, Current Amplification Factors (α, β and γ) and Relationship between them, Comparison of characteristics of Transistor in different configurations. **Amplifiers:** CB, CC and CE amplifiers, Transistor Biasing: selection of operating point, Load line analysis and operating point. Methods of Transistor biasing and stabilization (Fixed Base Bias, Bias with emitter resistor and voltage divider circuit)	12
III	**Multistage Transistor amplifiers:** RC Coupled amplifier (two-stage, concept of bandwidth, no derivation), Classification of amplifiers: Class A, B, AB and C amplifiers. **Feedback in Amplifiers:** Principle, Types of feedback, voltage gain, Advantages of negative feedback: Stabilization of gain, reduction in frequency distortion, reduction in non-linear distortions, reduction in noise, Effect of negative feedback on Input impedance, output impedance and bandwidth, Emitter follower circuit.	11
IV	**Oscillators:** Oscillations: Damped and Undamped Oscillations, Oscillatory circuit, Principle of Oscillation, Condition for self-sustained oscillation: Barkhausen Criteria for sustained oscillations, Essentials of Transistor oscillator, Selection of an Oscillator, Classification of oscillators, LC oscillators: Tuned collector, Tuned Base, Hartley Oscillator, Colpitt's Oscillator, RC oscillators: Phase Shift and Wein Bridge Oscillator.	11

	Practicum 1. To draw V-I characteristics of a semiconductor diode. 2. To study voltage regulation characteristics of Zener diode. 3. To verify inverse square law using photo cell. 4. To study characteristics of a solar cell. 5. To draw CB characteristics of a transistor and calculate transistor characteristics parameter. 6. To draw CE characteristics of a transistor and calculate transistor characteristics parameter. 7. Study of voltage doubler and tripler circuits. 8. Transistor as voltage amplifier in CB configuration. 9. Transistor as voltage amplifier in CE configuration. 10. Study of RC phase Shift Oscillator. **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**	30

SuggestedEvaluationMethods

InternalAssessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation:**Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.:**10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **: 20 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS

1. Electronic Devices and circuit theory by Boylested
2. Integrated Electronics by Jacob Millman, C. Halkias
3. Basic Electronics by B.L.Threja
4. Basic Electronics and linear circuits by N.N. Bhargav
5. Electronic Fundamentals and Applications by J.D.Ryder
6. Electronics made simple by V.K.Mehta
7. Fundamentals of Analog Electronics by J.B.Gupta
8. Analog Electronics by A.K.Maini
9. A textbook on Analog Circuits by A. Rajkumar
10. Basics of Analog Electronics by D.Prasad, Mohd. Ashrof, Z. Haseeb
11. Electronics: Analog and Digital by B. Raychaudhuri
12. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
13. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Kurukshetra University Kurukshetra
Undergraduate Programs
Course:MCC-12

Session: 2023-24	
Part A - Introduction	
Subject	Physics
Semester	6th
Name of the Course	Solid State Physics-I
Course Code	B23-PHY-602
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC
Level of the course (As per Annexure-I	300-399
Pre-requisite for the course (if any)	Appeared or passed the 5thsem (B.Sc Physical Science or equivalent)
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Have a brief idea about crystalline and amorphous materials, unit cell, primitive cell, miller indices, Bravais lattices and crystal structures of Zinc Sulphide, Sodium Chloride and Diamond. 2. Acquire knowledge about X-ray diffraction, Bragg's Law, experimental X-ray diffraction methods and about the reciprocal lattice to a simple cubic lattice, B.C.C. and F.C.C. lattice. 3. Understand about different types of bonding such as Vander wall's, Ionic, Covalent, hydrogen and Metallic bonding in crystals. 4. Analyze the concept of free electron gas model, density of states in one, two and three dimensions, Fermi energy, heat capacity of electron gas, Concept of thermal effective mass, Electrical conductivity and Ohm's law, Hall effect, and thermal conductivity of metals. 5. Learn about dielectric and ferroelectric properties of materials such as Polarization, Electric susceptibility, Polarizatibility, Complex Dielectric Constant,piezoelectric effect, pyroelectric effect, Ferroelectric effect, Curie-Weiss Law, PE Hysteresis

	loop.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

Part B-Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Crystal Structure-I:** Crystalline and glassy forms, liquid crystals, crystal structure, periodicity, lattice and basis, crystal translational vectors and axes. Unit cell and Primitive Cell, Winger Seitz primitive Cell, symmetry operations for atwo-dimensional crystal, Bravais lattices in two and three dimensions. Crystal planes and Miller indices, Interplanarspacing, Crystal structures of Zinc Sulphide, Sodium Chloride and Diamond.	11
II	**Crystal Structure-II:** X-ray diffraction, Bragg's Law and experimental X-ray diffraction methods. K-space and reciprocal lattice and its physical significance, reciprocal lattice vectors, reciprocal lattice to a simple cubic lattice, bcc and fcclattices. **Bonding in Crystals:**Vander Waal's bonding, Ionic bonding, Covalent bonding, example of hydrogen molecule, hydrogen bonding, Metallic bonding.	11
III	**Electronic Properties of Metallic Solids:** Free electron gas model, Energy levels and density of states in one, two and three dimensions, Fermi momentum, Fermi energy, Fermi temperature, Effect of temperature, heat capacity of electron gas (explicit calculation), Experimental heat capacity of metals, Concept of thermal effective mass, Electrical conductivity and Ohm's law, Experimental resistivity of metals, Matthiessen's rule, Motion in magnetic fields and Hall effect, Thermal conductivity of metals and Wiedmann-Franz law.	12

IV	**Dielectric Properties of Materials:** Polarization, Local electric field at an atom, Depolarization field, Electric susceptibility, Polarizatibility, ClasusiusMosotti equation, Classical theory of polarizability, Normal and Anomalous dispersion, Cauchy and Sellmeir relations, Langevin-Debye equation, Complex Dielectric Constant. **Ferroelectric properties of Materials:** Classification of crystals, piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electro strictive effect, Curie-Weiss Law, Ferroelectric domains, PE Hysteresis loop.	12
	<u>Practicum</u> 1. To determine Hall coefficient and mobility of a given semiconductor. 2. To measure the resistivity of a semiconductor (Ge) with temperature (up to 150^0 C) by four probe method. 3. To determine conductivity of given semiconductor crystal using four probe method. 4. To measure the magnetic susceptibility of Solids. 5. To measure the Coupling Coefficient of a piezoelectric crystal. 6. To measure the dielectric constant of a dielectric material with frequency. 7. To study the PE Hysteresis loop of a Ferroelectric crystal. 8. To determine the dielectric constant of paper. 9. To find the polarizability of a dielectric substance. 10. To determine the dielectric constant by charging and discharging of parallel plate capacitor. **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**	30

Suggested Evaluation Methods

InternalAssessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.:**10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **: 20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Solid State Physics by S. O. Pillai, New Age International Publisher, New Delhi.
2. Introduction to Solid State Physics by C. Kittel, Wiley India Pvt. Ltd.
3. Solid State Physics by R. K. Puri, V.K. Babbar, S. Chand & Co. New Delhi.
4. The Physics of Solids by Richard Turton, Oxford University Press.
5. Solid State Physics by Ashcroft and Mermin, Saunders college publshing.
6. Elements of Solid State Physics by M.N. Rudden, J. Wilson, Willey Blackwell Publishing.

7. Solid State Physics by A.J. Dekker, Luxmi PublicaionsSolid State Physics: Essential Concepts by D.W.Snoke
8. Essentials of Solid State physics by S.P.Kuila, New Central Book Agency.
9. Introductory Solid State Physics By H.P.Myres, CRC Press.
10. Solid State Physics by Vimal Kumar Jain, Springer Nature Switzerland Ag.
11. Fundamentals of Solid State physics by Saxena, Gupta, Pragati Prakashan Meerut.
12. Advanced practical Book for students, B. L. Flint and H. T. Wornsop, 1971, Asia Publishing House.
13. A text book of practical physics, I. Prakash & Ramakrishna, 11th edition., 2011 Kitab Mahal.
14. Elements of Solid-State Physics, J. P. Srivastava, 2nd Ed., 2006, Prentice Hall of India.
15. B.Sc Practical Physics, C. L. Arora, R Chand & Co. New Delhi

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-4

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">6th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Radiation Physics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-603</td></tr>
<tr><td>CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSE</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">300-399</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Appeared or passed the 5thsem (B.Sc Physical Science or equivalent)</td></tr>
<tr><td>CourseLearningOutcomes (CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand and explain radiation quantities and units
2. Analyze and have better understanding of biological effects of radiation
3. Have knowledge about the principles of Radiological Protection.
4. Have awareness about the radiation hazards’ types, their control and radiation emergency and preparedness.
5. Familiar with different techniques of detection of nuclear radiations.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks:70</td><td colspan="2">Time: 3hrs</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
</table>

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Sources of Radiations:** Sources of radiations: natural and artificial, Alpha, Beta and Gamma radiations, their origin and energetics, X-rays: Characteristic X-rays, Bremsstrahlung (continuous) X-rays, X ray targets, and Clinical X ray beams; Cosmic rays: Discovery, Nature of a cosmic rays, soft and hard component, and Geometric effects on cosmic rays; Terrestrial radiations: Radon gas and Radioactive isotopes of lighter elements, Radiation quantities and units: Activity, KERMA, Exposure, Dose, Equivalent Dose, Effective Dose, Annual Limit on Intake (ALI), and Derived Air Concentration (DAC)	10
II	**Biological Effects of Ionizing Radiations:** Introduction, Cell Biology: Structure and function of living cell, cell division-mitosis, meiosis and differentiation, central dogma of molecular biology, genetic codes-DNA, RNA and Proteins; Effect of Radiations on Cell: inhibition of cell division, chromosome aberrations, genes mutation, and cell death; Biological effects of Radiations on Human: Somatic Effects (Early effect) and Stochastic effect (Late effect).	12
III	**Principles of Radiological Protection:** Justification of Practice, Optimization of Practice, and Dose Limitations; Internal Exposure, Dose Limit for (i) Radiation Workers (ii) Public, Occupational Exposure of Women, Apprentices and Students. Production of Radioisotopes and Labeled Compounds: Introduction, Separation of Isotopes, Production of labeled compounds, Specific Activity of labeled compounds, Storage, Quality, and Purity of Radio-labeled compounds.	12
IV	**Radiation Hazards**: Internal and External Hazards; Evaluation and Control of Radiation Hazards, Radiation Shield, Monitoring of External Radiation, Control of Internal Hazard: (i) Containment of Source (ii) Control of Environment (iii) Contamination (iv) Air Contamination Monitoring (v) Personal Contamination Monitoring (vi) Decontamination Procedures; Radiation Emergency and Preparedness.	11

	Practicum **1.** To study the measurement of Background Radiation using G. M. Counter. **2.** To study the detection of alpha, beta and gamma radiations using G. M. Counter. **3.** Capturing and Detection of Radon in the Environment using G. M. Counter. **4.** Detecting low level radioactivity in food using G. M. Counter. **5.** To test the soil for harmful amounts of radiation inside and outside your institute using G. M. Counter. **6.** To assess radiation levels in the environment. **7.** Radiation detection in the scrap metal industry. **8.** To identify radioactive rocks and minerals. **9.** Radiation Dose mapping in the given area using Radiation Servey meter. **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**	30

SuggestedEvaluationMethods

InternalAssessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **: 20 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Radiation Oncology Physics: A handbook for teachers and students; International Atomic Energy Agency, Vienna, 2005.
2. Practical knowledge for Handling Radioactive Sources by Claus Grupen.
3. Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx.
4. Radiation Biology: A handbook for teachers and students; International Atomic Energy Agency, Vienna, 2010.
5. Measurement, Instrumentation and Experimental Design in Physics and Engineering, M. Sayer and A. Mansingh (Prentice Hall India, 2010).
6. Radiation Detection and Measurement, G. F. Knoll (John Wiley & Sons, Inc. 3rd Ed.,2000)
7. Physics & Engineering of Radiation Detection, S. N. Ahmed (Academic Press 2007)
8. Techniques for Nuclear and Particle Physics Experiments, W.R. Leo (Springer- Verlag 1987)
9. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
10. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-4

Session: 2023-24			
PartA - Introduction			
Subject	Physics		
Semester	6th		
Name of the Course	Thin Films and Characterization		
Course Code	B23-PHY-604		
CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	DSE		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (ifany)	Appeared or passed the 5thsem (B.Sc Physical Science or equivalent)		
CourseLearningOutcomes (CLO):	After completing this course, the learner will be able to: 1. Familiar about the Thin Film deposition technology and various deposition techniques used for fabrication of thin films. 2. Understand the basic process of growth of thin films on a substrate and how to monitor and calculate the thickness of the film. 3. Familiar about the various characterization tools used for the study of optical, structural and morphological properties of thin films. 4. Acquire knowledge of working principle of basic elements used in thin film deposition technology. 5. Learn to present observations, results, analysis and different concepts related to experiments of fabrication and characterization of thin films.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**		**Time:3hrs**	

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Thin Film Deposition Technology:**Physical Deposition Processes: Introduction, Schematic diagram and working process of (a) Vacuum Evaporation (b) Thermal Evaporation by Resistive heating; Flash evaporation; Arc Evaporation; Exploding wire technique; Laser Evaporation; Electron Beam Evaporation.Chemical Deposition Processes: Introduction, Schematic diagram and working process of (a) Electro Deposition; Electrolytic Deposition; Electroless Deposition; Chemical Vapour Deposition (CVD); Anodic oxidation.	12
II	**Thin Film Deposition Cathodic Sputtering Technology:**Introduction, The Sputtering Yield; Glow-discharge sputtering, Pressure, Deposit Distribution Current and Voltage Dependence, Cathode, Contamination Problem, Deposition Control, Sputtering Variants, Low-pressure Sputtering: RF Sputtering, Ion Beam Sputtering, Reactive Sputtering, Ion Beam Sputtering, Reactive Sputtering.	10
III	**Film Thickness: Thin Film, Foil and Sheet:** Basic introduction, rangeof their thickness and difference between these three. **Monitoring Processes:** Introduction, schematic diagram and working process of Optical Monitoring, Quartz Crystal monitoring system. **Thin Film Characterization Techniques:**Introduction and measurement of Film thickness by Interference method. Optical Constants: Measurement of Intensity of light as a function of wavelength by Spectrophotometer; Determination of refractive index, absorption coefficient and thickness of thin film by Ellipsometry; Absorption measurement by Calorimetry. Crystalline structure and morphological properties of thin films. Electrical conduction, Defects, Hardness, Humidity and Temperature testing,	11
IV	**Basic Elements of Vacuum Technology:** Vacuum: BasicConcept, different levels of vacuum and terms used in vacuum technology. Atmosphere and how atmospheric pressure is created. Basic concept and measure of Gas Pressure. Brief history of vacuum its requirement and applications in science and technology. **Vacuum Pumps:** Basicprinciplesandprocessesforproductionofvacuum. Construction, working, advantages and disadvantages of Rotary, Roots, Diffusion and Turbo molecular Pumps.	12

	Vacuum Measuring Gauges: Introduction construction and working of different types of vacuum measuring Gauges: (a) Direct Measuring Gauges; Bourdon Vacuum Gauge, Mercury Manometer, Macleod Gauge (b) Indirect Measuring Gauges; Thermal Conductivity Gauge, Thermocouple Gauge, Pirani Gaug, Leak detection.	
	Practicum 1. Determination of thickness of a thin film optically. 2. Determination of electrical conductivity of a thin film. 3. Study of surface roughness of a thin film by optical microscope. 4. To measure the I-V characteristics of a thin film. 5. To calculate the sheet resistance of thin films of different thickness and compare the results. 6. Determination of thickness of a given sheet or foil using G M Counter. 7. Study of grain size in the surface of a polycrystalline thin film by optical microscope. 8. To study the thin film interference and to find out its thickness. **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**	30
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination: 50 Marks** **: 20 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Thin Film Phenomena - Kasturi L. Chopra, McGraw Hill Book Company. 2. Nuclear Measurement Techniques, K. Sriram, (1986), AEWP, New Delhi 3. Hand Book of Thin Film Technology - Leon 4. Handbook of Analytical Instrumentation - R.S. Khandpur 5. Vacuum Science and Technology - A. Roth. 6. Thin Film technology –A Layman's Perception, V.V. Shah, A. Basu, Vigyan Prasar(An Autonomous Organisation Under the DST, Govt. of India 7. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi 8. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House		

Undergraduate Programs
Course: DSE-5

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">6th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Numerical Methods in Physics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-605</td></tr>
<tr><td>CourseType: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSE</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">300-399</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Appeared or passed the 5thsem (B.Sc Physical Science or equivalent)</td></tr>
<tr><td>CourseLearningOutcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand different type of errors, their propagation, and to minimize errors while writing a program.
2. Solve a set of simultaneous linear algebraic equations numerically and able to find numerically the eigenvalues and eigenvectors of matrices using polynomial and power methods.
3. Solve numerical problems involving interpolation and/or extrapolation using different methods.
4. Solve ordinary and partial differential equations using numerical methods.
5. Understand how to develop a programme for a particular problem and it will improve logical thinking that helps to solve scientific problems using Python language.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks:70</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">PartB-Contents of the Course</td></tr>
</table>

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Errors and Solutions of Algebraic Equations:** Round off error, Truncation error, Machine error, Random error, Propagation of errors. Loss of Significance: Significant Digits, Computer caused loss of significance, Avoiding loss of significance in subtraction. Solutions of algebraic equations: Bisection method, Iteration method, Method of false position, Newton-Raphson method, Convergence conditions, Muller's method, Secant Method.	12
II	**Systems of Linear Equations and Eigenvalue Problem:**Solutions of simultaneous linear algebraic equations: Gauss elimination method, Gauss Jordan elimination method, Doolittle method, Matrix inversion method, Ill-conditioned matrix and error correction, Jacobi Method, Gauss Seidel iterative method, Matrix eigenvalues and eigenvectors: Polynomial method, Power method.	11
III	**Interpolation and Curve fitting:**Interpolation and Extrapolation: Finite differences, Forward differences, Backward differences, Central differences, Newton's formula for interpolation, Gauss central difference formula, Stirling's formula, Bessel's formula, Lagrange's interpolation formula, error of interpolation, Least square curve fitting: The principle of least square fitting, Linear regression, Polynomial regression, Fitting exponential and trigonometric functions, Data fitting with cubic splines, Data fitting using Gnuplot.	11
IV	**Solutions of ordinary differential equations:**Numerical solution of ordinary differential equations: Single step method, multi-step method, Taylor's series method, Euler's method, Modified Euler's method, Fourth-order Runge Kutta method, Cubic splines method; Second order differential equations: Initial and boundary value problems.	11
	Practicum 1. Least Square fitting (Linear). 2. Least square fitting (polynomial) 3. Least square fitting (exponential function) 4. Solution of Simultaneous Linear Algebraic equations by Gauss-Jordan elimination method.	

	5. To find roots of an equation of degree 1, 2 and 3 by using Bisection method. 6. Numerical Integration using Gauss quadrature methods for one and two-dimensional integrals. 7. Solution of second-order differential equation using Runge-Kutta method. 8. Finding eigenvalues and eigenvectors of square matrices. 9. To solve differential equations by Euler's method. 10. Interpolation and extrapolation using Bessel's formula. **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**	
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** Mid-Term Exam: **Nil**		**End Term Examination : 50 Marks** **: 20 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. R C Desai, Fortran Programming and Numerical methods, Tata McGraw Hill, New Delhi. 2. P B Patil and U. P. Verma, Numercal Computational Methods, Narosa Publishing House 3. S S Sastry Introductory methods of numerical Analysis, Prentice Hall of India Pvt. Ltd. 4. R C Verma, P K Ahluwalia and K C Sharma, Computational Physics an Introduction, New Age International Publisher. 5. C Balachandra Rao and C K Santha, Numerical Methods, University Press 6. K E Atkinson, An introduction to numerical analysis, John Wiley and Son		

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-5

Session: 2023-24			
PartA - Introduction			
Subject	Physics		
Semester	6^{th}		
Name of the Course	Applied Nuclear Techniques		
Course Code	B23-PHY-606		
CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	DSE		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (ifany)	Appeared or passed the 5^{th}sem (B.Sc Physical Science or equivalent)		
CourseLearningOutcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the basic principles of working and applications of various Particle Accelerators, Synchrotron and Synchrocyclotrons. 2. Familiar about the Proton induced X-ray Emission spectroscopy for elemental analysis and its variety of applications in various field of science and technology. 3. Acquire knowledge of working principle of X-ray Fluorescence spectroscopy and its application in material research and industry. 4. Familiar about the basic principle of Neutron Activation analysis and possible applications in Material Science, Chemistry, Biology, radiation assessment, mineral exploration, Medical and Forensic Science 5. Learn to present observations, results, analysis of spectra recorded using different nuclear techniques.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Particle Accelerators**: Basic principle, construction, working, advantages and limitations of Van-de-Graff, Basic principle, construction, Theory, working, advantages and Relativistic limitation of Cyclotron. Magnetic Resonance Accelerator. Synchrotrons: Electron synchrotron, Proton synchrotron. Basic principle, construction, theory, advantages and limitations of Synchrocyclotrons. Medical applications of accelerators, Mega volt therapy.	12
II	**Nuclear Spectroscopy Technique:** Charged Particle Induced X-ray Emission (PIXE) spectrometry: Basic Principle, X-ray production process, Radiative and Non-radiative transitions, Coster Krönig transitions, continuous background, Brenmsstrahlung, PIXE set-up, Instrumentation, Qualitative analysis: Energy calibration, comparison with standard. Quantitative analysis: Absolute method, Relative method, Relationship between X-ray intensities and concentrations, Limits of detection, Application of PIXE in air and water pollution industries.	12
III	**X-rays Fluorescence Spectrometry (XRF)**: Nature and origin of X-rays, characteristic X-rays, notation for spectrum, Continuous spectra, Duane - Hunt Law, Relationship between X-rays emission and atomic number, Sources of X-rays: X-ray tube, Function and requirements, Radioisotope source, XRF spectrometer, wave length dispersive devices, Energy dispersive devices, pulse height selection. Application of XRF in various fields, Advantages and disadvantages of XRF.	10
IV	**Neutron Activation Analysis (NAA)**: Introduction, Theory of activation method, Neutron energy distribution, Classification of neutron activation methods: Prompt γ -ray neutron activation, Delay γ-ray neutron activation. Instrumental NAA. Analysis of the gamma spectra, Applications: NAA for semiconductor materials, Soil science, Geological science, Accuracy and sensitivity of NAA.	11

	Practicum 1. Radiation dose measurement. 2. To verify Inverse square law for gamma rays using given radioactive source 3. Qualitative Analysis of recorded PIXE spectra for chemical composition of air. 4. Qualitative Analysis of recorded PIXE spectra for chemical composition of water. 5. Estimation of weight percentage of elements present in a synthesized sample using XRF spectra. 6. Determination of trace elements concentration in the bulk of sample using Neutron Activation Analysis. 7. Measurement of different X-rays energies emitted from a sample using recorded XRF spectra. 8. Determination of elemental composition in the bulk of sample using Neutron Activation Analysis. **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**	30
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination :50 Marks** **: 20 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Introduction to Nuclear and Particle Physics, V.K. Mittal, R.C. Verma, S.C. Gupta, PHI Learning Private Limited, New Delhi. 2. Instrumental methods of Analysis - Hobart H. Willard, et al. 7th edition, CBS Publishers. 3. Handbook of Analytical Instrumentation – R.S. Khandpur. 4. Principles of Instrumental Analysis, Douglas A Skoog et al. Saunders Golden Sunbrust Series. 5. Particle Induced X-ray Emission spectroscopy, Sten A.E. Johnson et al. John Willey & Sons, New York. 6. Principles and Practice of X-ray spectroscopy - Eugene, Bertin Plenum Press. 7. An Introduction to X-ray Spectrometer, R. JenKins, Heydon London Publication. 8. Neutron Activation Analysis - D. De Soete et al. Johan Wiley and Sons.		

9. Activation Analysis: Vol. I and II - Z.B. Alfarsi, CRC Press.
10. X-rays in Atomic and Nuclear Physics, N.A. Dyson, Cambridge University Press, New York.
11. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
12. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-H1

Session: 2023-24	
PartA - Introduction	
Subject	Physics
Semester	7^{th}
Name of the Course	Advanced Mathematical Physics
Course Code	B23-PHY-701
CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	CC
Level of the course (As per Annexure-I	400-499
Pre-requisite for the course (ifany)	Appeared or passed the 6^{th} Sem (B.Sc. Physical Science with Physics as major subject)
CourseLearningOutcomes (CLO):	After completing this course, the learner will be able to: 1. Learn basics of group theory and prepare group multiplication tables and to understand reducible and irreducible group representations and construct character table of symmetry groups of equilateral triangles, rectangle and square. 2. Find the Fourier series expansion and develop Fourier integrals and learn properties of Fourier and Laplace transforms and evaluate the Fourier and Laplace transforms of functions and derivatives. 3. Obtain explicit expressions of Bessel and Legendre polynomials by solving the concerned differential equations. Find explicit expressions of Hermite, Laguerre, Bessel and Legendre polynomials using the corresponding generating functions and derive various recurrence relations among these special functions. 4. Derive Cauchy integral theorem and Cauchy integral formula and find Taylor and Laurent series expansion of functions of complex variable. One can understand the calculus of residue and evaluate some typical definite integral using the method of contour integration.

Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Group Theory:** Fundamentals of Group theory: Definition of a group and illustrative examples, Group multiplication table, rearrangement theorem, cyclic groups, sub-groups and cosets, permutation groups, conjugate elements and class structure, normal devisors and factor groups, isomorphism and homomorphism, class multiplication. Group representation: Reducible and irreducible representations, great orthogonality theorem (without proof) and its geometric interpretation, character of a representation, construction of character table with illustrative examples of symmetry groups of equilateral triangle, rectangle and square. Decomposition of reducible representation, the regular representation. The elements of the group of Schrodinger equation.	15
II	**Fourier Series and Integral Transforms:** Fourier series, General properties, Advantages and applications, Gibbs phenomenon, Development of the Fourier integral, Inversion theorem, Fourier transform, Fourier transform of derivatives, Momentum representation, Laplace transform, Laplace transform of derivative, Properties of Laplace transforms, Faltung's theorem, Inverse Laplace transformation.	15
III	**Special Functions:** Bessel Functions: Bessel functions of the first kind $J_n(x)$, Generating function, Recurrence relations, Expansion of $J_n(x)$ when n is half an odd integer, Integral representation; Legendre Polynomials $P_n(x)$: Generating function, Recurrence relations and special properties, Rodrigues' formula, Orthogonality of $P_n(x)$; Associated Legendre polynomials, Spherical harmonics, Addition theorem for spherical harmonics, Hermite and Laguerre Polynomials: generating function & recurrence relations only.	15

IV	**Functions of a complex variable and calculus of residues:** Complex algebra, Functions of a complex variable, Cauchy's integral theorem, Cauchy's integral formula; Taylor and Laurent expansions; Singularities; Cauchy's residue theorem, Cauchy principle value, Singular points and evaluation of residues, Jordan's Lemma; Evaluation of definite integrals of the type: $\int_0^{2\pi} f(\sin\theta, \cos\theta)\, d\theta$; $\int_{-\infty}^{\infty} f(x)dx$; $\int_{-\infty}^{\infty} f(x)e^{iax}dx$ using Cauchy's residue theorem.	15
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**		**End Term Examination : 70 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Group Theory and Quantum Mechanics by M. Tinkam. 2. Mathematical Methods for Physicists (4th edition) by G. Arfken. 3. Mathematical Methods for Physicists (6th edition) by Arfken and Weber. 4. Mathematical Physics for Physicists & Engineers by L. Pipes. 5. Introduction to Mathematical Physics by C. Harper		

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-H2

<table>
<tr><th colspan="4">Session: 2023-24</th></tr>
<tr><th colspan="4">PartA - Introduction</th></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">7th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Advanced Classical Mechanics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-702</td></tr>
<tr><td>CourseType:
(CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">CC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">400-499</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Appeared or passed the 6th Sem (B.Sc. Physical Science with Physics as major subject)</td></tr>
<tr><td>CourseLearningOutcomes (CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Demonstrate a basic and advanced knowledge of Lagrangian and Hamiltonian Formulations and solve related problems. Identify the cyclic coordinates and understand their importance in Hamiltonian formulation.
2. Acquire knowledge of canonical Transformation and various generating functions for this transformation. Develop a deep understanding to tackle the problems of classical mechanics under small oscillations.
3. Demonstrate the concept of motion of a particle under central force and apply advanced methods to deal with central force problems. Use Hamilton-Jacobi theory for finding the solutions of various Classical systems.
4. Understand the foundations of nonlinear dynamics in general and chaotic motion and fractals, in particular. Perform stability analysis of cubic anharmonic oscillator and undamped pendulum, and find chaotic trajectories.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>4</td><td>-</td><td>4</td></tr>
</table>

Contact Hours	4	-	4

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Lagrangian and Hamiltonian formulations:** Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Principle of Least Action and its applications, Canonical Transformation; The Hamiltonian Formalism: Canonical formalism, Hamiltonian equations of motion, The physical significance of the Hamiltonian, Cyclic coordinates, Rauthian procedure and equations of motion, Derivation of Generating functions, examples, properties, Derivation of Hamiltonian equations of motion from variational principle.	14
II	**Poisson bracket and theory of small oscillations**: Poisson bracket, special cases of Poisson bracket, Poisson theorem, Poisson bracket and canonical transformation, Jacobi identity and its derivation, Lagrange bracket and its properties, the relationship between Poisson and Lagrange brackets and its derivation, the angular momenta and Poisson bracket, Liouville's theorem and its applications. **Theory of small oscillations**: Formulation of the problem, Eigenvalue equation and the principle axis transformation, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule.	15
III	**Two-body central force problem and H-J theory:** Two body central force problem: Reduction to the equivalent one body problem, the equation of motion and first integrals, classification of orbits, the Virial theorem, the differential equation for the orbit, integrable power law in time in the Kepler's problem, the Laplace-Runge-Lenz vector, scattering in central force field. **H-J Theory:** H-J equation and their solutions, use of H-J method for the solution of harmonic oscillator problem, Hamilton's principle function, Hamilton's characteristic function and their properties, Action angle variables for completely separable systems, the Kepler's problem in action angle variables.	16

IV	**Introductory non-linear dynamics:** Classical Chaos: Linear and nonlinear systems, periodic motion, Perturbation and KAM theorem, dynamics in phase space, phase portraits for conservative systems, attractors, classification and stability of equilibrium points, stability analysis of cubic anharmonic oscillator and undamped pendulum, chaotic trajectories and Liapunov exponent, Poincare Map, Henon-Hiels Hamiltonian, bifurcation, driven-damped harmonic oscillator, the logistic equation, Fractals and dimensionality.	15
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**		**End Term Examination : 70 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Classical Mechanics (3rd ed., 2002) by H. Goldstein, C. Poole and J. Safko, Pearson Edition 2. Classical Mechanics by John R Taylor, 2005, University Science Books, USA 3. Chaos and Integrability in nonlinear dynamics: An introduction (1989) by Michael Tabor 4. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajasekar 5. Classical Mechanics, J.C. Upadhyaya, Himalaya Publishing House.		

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-H3

Session: 2023-24	
Part A - Introduction	
Subject	Physics
Semester	7th
Name of the Course	Quantum Mechanics-I
Course Code	B23-PHY-703
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC
Level of the course (As per Annexure-I	400-499
Pre-requisite for the course (if any)	Appeared or passed the 6th Sem (B.Sc. Physical Science with Physics as major subject)
Course Learning Outcomes (CLO):	1. After completing this course, the learner will be able to: 2. Realize the basic quantum-mechanical view point, and learn its wave mechanical and matrix formulations for a non-relativistic situation. Solve the Schrödinger wave equation for eigenfunctions and eigenvalues for simple interaction potentials, including harmonic and central potentials. 3. Construct matrices for observables and wave functions in different representations, and apply the matrix theory for calculating eigenvalues and eigenfunctions of linear harmonic oscillator. Describe the time-development of a quantum system in Schrödinger, Heisenberg and Interaction pictures, and to envisage the same in Hilbert space. 4. Calculate the eigenvalues and eigenfunctions for the orbital and general angular momenta, along with the matrix representation of angular momentum. Perform quantum-mechanical addition of two general angular momenta, and calculate Clebsch-Gordan coefficients for some simple situations. 5. Grasp the concepts of identity, indistinguishability, and see how eigenstates of a system of identical particles bifurcate into totally symmetric and anti-symmetric ones.

	Find the spin and total wave functions for a system of two identical spin ½ particles, and comprehend connection among spin, symmetry and statistics of identical particles.		
Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

PartB-Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Schrödinger formulation of Quantum Mechanics:** Recapitulation of basic concepts: Why quantum mechanics? Two-slit experiment with *em* radiation and matter particles, Quantum-mechanical view point, The Schrödinger wave equation, Expectation values, Ehrenfest theorem; Interpretative postulates of quantum mechanics: Dynamical variables as Hermitian operators, Eigenvalues and eigenfunctions, Expansion in eigenfunctions; Illustration of postulates for energy and momentum: Orthonormality of eigenfunctions, Reality of eigenvalues, Closure property, Probability function and expectation value, Co-ordinate and momentum representations of wave function, Uncertainty principle for two arbitrary observables; Problems: A charged particle in a uniform static magnetic field (eigenfunctions and Landau levels); The Hydrogen atom (reduced mass, radial wave functions and energy eigenvalues).	15
II	**Matrix formulation of Quantum Mechanics:** Preliminaries: Hermitian and unitary matrices, Transformation and diagonalization of matrices, Matrices of infinite rank; Representation of observables and wave functions as matrices, Transformation theory, choice of basis, change of basis, unitary transformations, Hilbert space representation; Dirac's ket and bra notations; Time-development of quantum system: Schrödinger, Heisenberg and Interaction pictures, Link with classical equations of motion, Quantization of a classical systems; Application to motion of a particle in an em field; Matrix theory of the harmonic oscillator: Spectrum	15

	of eigenvalues and eigenfunctions, Matrices for position, momentum and energy operators (energy representation).	
III	**Quantum theory of Angular Momentum:** Orbital angular momentum operator **L**, Cartesian and spherical polar co-ordinate representation, Commutation relations, Orbital angular momentum and spatial rotations, Eigenvalues and eigenfunctions of $\mathbf{L}^2$ and L_z, Spherical harmonics; General angular momentum **J**: Eigenvalues and eigenfunctions of $\mathbf{J}^2$ and J_z, Matrix representation of angular momentum operators, Spin angular momentum, Wave function including spin (Spinor); Spin one-half: Spin eigenfunctions, Pauli spin matrices; Addition of two angular momenta, Clebsch-Gordan coefficients and their calculation for $j_1= j_2 =1/2$, $j_1=1$, $j_2 =1/2$ and $j_1= j_2 =1$; The Wigner-Eckart theorem.	15
IV	**Many-particle systems and identical particles:** Many-particle Schrödinger wave equation, Stationary-state solutions; Systems of identical particles, Physical meaning of identity, Principle of indistinguishability, Exchange and transposition operators, Totally symmetric and anti-symmetric wave functions, Time-invariance of symmetry, Construction of symmetric and anti-symmetric wave functions, Connection among spin, symmetry and statistics of identical particles, Fermions and bosons; Spin and total wave functions for a system of two spin ½ particles, Pauli exclusion principle and Slater determinant; Application to the electronic system of the helium atom (*para*- and *ortho*-helium); Limit of distinguishability of identical particles.	15
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**10 Marks** • Mid-Term Exam: **15 Marks**		**End Term Examination : 70 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Quantum Mechanics (3rd edition) by L. I. Schiff 2. Quantum Mechanics (2nd edition) by B. H. Bransden and Joachain 3. Quantum Mechanics (3rd edition) by S. Gasiorowicz 4. Quantum Mechanics (3rd edition) by E. Merzbacher 5. Quantum Mechanics by John L. Powell and B. Crasemann 6. Quantum Mechanics by A. K. Ghatak and S. Loknathan 7. Introductory Quantum Mechanics (4rd edition) by Richard L. Liboff 8. Quantum Mechanics: Concepts and Applications (2nd edition) by N. Zettili		

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-6/ DSE-H1

Session: 2023-24	
PartA - Introduction	
Subject	Physics
Semester	7th
Name of the Course	Electronic Devices and Circuits-I
Course Code	B23-PHY-704
CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	DSE
Level of the course (As per Annexure-I	400-499
Pre-requisite for the course (ifany)	Appeared or passed the 6th Sem (B.Sc. Physical Science with Physics as major subject)
CourseLearningOutcomes (CLO):	After completing this course, the learner will be able to: 1. Be aware of the general characteristics of important semiconductor materials. Develop a deep understanding of the basic design, operation and characteristics of a pn-junction and a BJT along with knowledge of the basic network theorems and their applications in electronic circuit analysis. 2. Learn to devise and analyze various transistor amplifier models. Understand the concept of negative feedback and its importance in amplifiers. 3. Perform a load-line analysis and design of various biasing schemes in amplifiers. Acquaint with the frequency response of variously coupled amplifiers and sources of noise in electronic devices. 4. Gain knowledge of classification, sources of distortions and their estimation, operation and determination of efficiency of power amplifiers. Clearly understand the need of regulation, operation and circuit analysis of different voltage and current regulators.

Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Basics of pn-junction, BJT and Network Theorems:** Semiconductors: intrinsic and extrinsic semiconductors, charge densities in p and n type semiconductors, conduction by charge drift and diffusion, the pn-junction, energy level diagrams of pn-junction under forward and reverse bias conditions, derivation of pn-diode equation, Zener diode, Zener and avalanche breakdowns, clipping and clamping circuits; The bipolar junction transistor: basic working principle, configurations and characteristics, voltage breakdowns, Network theorems: node, mesh, superposition, Miller's, Thevenin's and Norton's theorems.	15
II	**Amplifier Models, Feedback and Biasing**: Two port network analysis: active circuit models, gain in decibels, equivalent circuit for BJT, the transconductance model for BJT, analysis of CE, CB, and CC amplifiers; An amplifier with feedback, effect of negative feedback on gain and its stability, distortions, input and output impedances of amplifiers, Location of quiescent (Q) point, biasing circuits for amplifiers: fixed bias, emitter feedback bias & voltage feedback bias, bias compensation, bias techniques for linear integrated circuits, thermal runaway and thermal stability.	15
III	**Frequency Response of Amplifiers:** The amplifier pass band, mid frequency range response of a direct coupled CE cascade, the high frequency equivalent circuit (Miller effect), the high frequency response of a direct coupled CE cascade, the frequency response of RC and transformer coupled CE amplifiers, gain-frequency plots of amplifier response (Bode plots), bandwidth of cascaded amplifiers, bandwidth criterion for the transistor, the gain-bandwidth product, composite amplifier designs, bootstrapping in amplifiers, noise in amplifiers, noise figure.	15

IV	**Power Amplifiers and Regulators:** Power amplifiers: class A large signal amplifier, second and higher order harmonic distortions, the transformer coupled power amplifier, impedance matching, efficiency, push-pull amplifiers, class-B amplifiers, complementary stages, cross over distortions, class-AB operation, heat sinks, derating curve; Electronic voltage regulators: basic operation and analysis of Zener diode voltage regulator, single BJT shunt and series regulators, feedback series BJT regulator and current regulator, overload and short circuit protection circuits.	15
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**		**End Term Examination : 70 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Electronic fundamentals and applications (5^{th} ed.) by J. D. Ryder 2. Integrated Electronics by J. Millman and C. C. Halkias 3. Circuits and Networks: Analysis and Synthesis by A Sudhakar and S.S. Palli 4. Electronic devices and circuits by Y. N. Bapat 5. Pulse, digital and switching waveforms by J. Millman and H. Taub 6. Millman's Electronic Devices & Circuits by J. Millman, C. C. Halkias &Satyabrata Jit 7. Electronic Devices & Circuit Theory by Robert L Boylestad& Louis Nashelsky 8. Solid state Electronic Devices by B.G. Streetman and S.K. Banerjee		

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-6/ DSE-H1

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">7th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Sensors and Transducers</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-705</td></tr>
<tr><td>CourseType:
(CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSE</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">400-499</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Appeared or passed the 6th Sem (B.Sc. Physical Science with Physics as major subject)</td></tr>
<tr><td>CourseLearningOutcomes (CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Learn the basics of sensors and transducer
2. Explain the thermal sensors
3. Learn about the magnetic Sensors
4. Know the recent trends in sensor technologies and their applications.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>4</td><td>-</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>4</td><td>-</td><td>4</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks:70</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter</u>
1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.</td></tr>
</table>

4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Basics of Sensors and Transducers**: Definition, Principles, Classification, Parameters, Environmental Parameters, Characterization: Electrical, Mechanical and Thermal, Optical, Chemical/Biological. Resistive Potentiometer, Strain Gauge and types, Inductive Sensors: Sensitivity and Linearity of the Sensor, Ferromagnetic Plunger Type Transducers, Inductance with a Short-circuited Sleeve, Transformer Type Transducer. Electromagnetic Transducer, Magnetostrictive Transducer, Capacitive Sensors: Parallel Plate Capacitive Sensor, Serrated Plate Capacitive Sensor, Variable Permittivity or Variable Thickness Dielectric Capacitive Sensor, Stretched Diaphragm Variable Capacitance Transducer, Electrostatic Transducer.	16
II	**Thermal sensors:**Gas Thermometric Sensors ,Thermal Expansion Type Thermometric Sensors , Resistance Change Type Thermometric Sensors: RTD - materials, construction, types, working principle, Thermistor : materials, construction, types, working principle, Thermo emf sensors: Thermocouple – Principle and types, Radiation sensors: Principle and types, Quartz Crystal Thermoelectric Sensors, Heat Flux Sensors	15
III	**Magnetic Sensors:** Principles and working: Yoke Coil Sensors, Coaxial Type Sensors, Force and Displacement Sensors; Magnetoresistive Sensors: Anisotropic Magnetoresistive Sensing, Semiconductor Magnetoresistors, Active Semiconductor Magnetic Sensors, Hall Effect and Sensors, Inductance and Eddy Current Sensors, Angular/Rotary Movement Transducers.	15
IV	R**ecent Trends in Sensor Technologies:** Film Sensors, Semiconductor IC technology-Standard Methods, Microelectromechanical Systems and Nano-sensors. **Sensors Applications:** On-board Automobile Sensors, Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Medical Diagnostic Sensors, Sensors for Environmental Monitoring.	14

SuggestedEvaluationMethods

InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination : 70 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Sensors and Transducers, D Patranabis, PHI, 2nd Edition.
2. Measurement Systems: Application and Design, E. A. Doebelin, McGraw Hill, New York
3. Instrumentation- Devices and Systems, Rangan, Sarma, and Mani, Tata-McGraw Hill, 2nd edition.
4. Electronic Instrumentation, H.S Kalsi, McGraw Hill, 4th edition.
5. A course in Electrical & Electronic Measurement and Instrumentation, A.K. Sawhney, Dhanpat Rai and Company Private Limited.
6. Transducers and Instrumentation, D.V.S. Murthy, 2nd Edition, Prentice Hall of India Private Limited, New Delhi, 2010.
7. Transducer Engineering, S. Renganathan, Allied Publishers, 2005
8. Instrumentation Measurements and Analysis, Nakra & Choudhary, Tata McGraw-Hill, 2nd edition.

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: PC-H1

Session: 2023-24			
PartA - Introduction			
Subject	Physics		
Semester	7th		
Name of the Course	Practicum Course		
Course Code	B23-PHY-706		
CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	PC		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (ifany)	Appeared or passed the 6th Sem (B.Sc. Physical Science with Physics as major subject)		
CourseLearningOutcomes (CLO):	After successful completion of the course on Physics Laboratory-I (electronics), a student will be able to: 1. Draw and understand the frequency response of different Filter circuits and a RC-coupled amplifier in its three configurations. Also measure important parameters of rectifier, filter, voltage regulator and pn-junction circuits. 2. Design and draw load characteristics of a push-pull amplifier and generate and determine the frequency of saw-tooth waves using UJT.Design and verify truth tables of the basic logic gates. 3. Design and understand the operations of astable multivibrator, clipping and clamping circuits.Design and understand the operations of differentiating, integrating, modulation and demodulation circuits. 4. Measure the sensitivities of X and Y plates of a CRO and determine frequency and phase-difference using CRO. Also draw the characteristics of various opto-electronic devices and determine high resistance by leakage and k/e using a transistor.		
Credits	Theory	Practical	Total
	-	4	4

Contact Hours	-	8	8

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time: 4hrs**

PartB-Contentsofthe Course

Instructions for Practical examiners

1. Student will perform at least 08 experiments.
2. The examiner will assign one practical at the time of end term examination.

	Practicum 1. To study the frequency response of low-pass, high-pass and band-pass filters. 2. To study the rectifier circuits and to measure the ripple factors of C, L and π-section filters. Also study the stabilization characteristics of a voltage regulator consisting of IC-741. 3. To study the load characteristics of a class-B push-pull amplifier. 4. To generate saw-tooth waves using UJT and find its frequency. 5. To draw frequency response characteristics of a RC-coupled single stage BJT amplifier in all the three configurations. 6. To design circuits for OR, AND, NOT, NAND and NOR logic gates and verify their truth tables. 7. To measure (a) phase difference, (b) deflection sensitivities and (c) frequency of an unknown ac signal using CRO. 8. To study the astable multivibrator. 9. To study the clipping and clamping circuits. 10. To study the differentiating and integrating circuits. 11. To determine various parameters of a pn-junction diode. 12. To study the modulation and demodulation circuits. 13. To draw characteristics of opto-electronic devices. 14. To determine high resistance by leakage and k/e using a transistor.	120

SuggestedEvaluationMethods

InternalAssessment: ➢ **Practicum (30 Marks)** • Class Participation: **05 Marks** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination : 70 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Electronic fundamentals and applications (5^{th} ed.) by J. D. Ryder
2. Integrated Electronics by J. Millman and C. C. Halkias
3. Circuits and Networks: Analysis and Synthesis by A Sudhakar and S.S. Palli
4. Electronic devices and circuits by Y. N. Bapat
5. Pulse, digital and switching waveforms by J. Millman and H. Taub

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-HM1

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	7^{th}		
Name of the Course	Basics of Laser Physics and Fiber Optics		
Course Code	B23-PHY-707		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-M		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Appeared or passed the 6^{th}sem with physics as major subject		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the basic principle of laser, Einstein's coefficients and their physical significance. Line broadening and its reasons 2. Qualitative understanding of different lasing mechanism, variation of output laser power around threshold and basic idea of oscillating of modes in laser cavity and their roles in propagation 3. Understand about optical fibres and its classification, basic principle involved in propagation of light through optical fibre and its application in communication 4. Have the idea of Fibre materials, Fibre Cables and Fabrication Techniques.		
Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**		**Time:3hrs**	

Part B-Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Introduction to Laser:** Spontaneous and Stimulated Absorption and Emission of radiation, Main features of a laser: Directionality, high intensity, high degree of coherence, spatial and temporal coherence, Einstein's coefficients and possibility of amplification, Kinetic of optical absorption, Population inversion: A necessary condition for light amplification, resonant cavity and laser pumping, Threshold condition for laser emission, Line Broadening mechanisms: Homogeneous broadening (Natural Broadening, Collision broadening); Inhomogeneous broadening (Doppler Broadening).	15
II	**Lasers:** Principle, Construction & working of He-Ne Laser, Ruby Laser, Semiconductor junction Laser, N2-Laser, CO2 laser. **Laser Applications**: Spatial Frequency Filtering, Holography, Laser induced Fusion, Lasers in Isotope Separation. Application of Laser Technology in material processing (Drilling, Cutting, Welding), Medicine, Industry and Military.	15
III	**Optical fibres:** Introduction; Basic structure and classification of optical fibres, Single mode and monomode optical fibres, Propagation of light in optical Fibres, Numerical Aperture, acceptance angle, meridional and skew rays, number of modes and cut off parameters of fibres, pulse dispersion in step index fibres and graded index fibres, material dispersion. Advantages and disadvantages of fibres, Application of optical fibres.	15
IV	**Fibre Materials & Fabrication Techniques**: Glass fibre, plastic fibre, losses of fibres; bending losses, intrinsic fibre losses, scattering losses and absorption losses. Fibre Cables: Fibre cable construction, Strength member, cable tensile loading, Minimum bend radius, Losses incurred during installation of cables or during subscriber service, testing of cables, cable selection criteria. Outside vapour phase oxidation, vapour phase axial deposition, modified chemical vapour deposition.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination : 70 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS

1. Laser and Optical Engineering P.Das, Narosa Publication.
2. Lasers and Nonlinear Optics - B.B. Land.
3. Optical Electronics - A Ghatak and K. Thyagarayan.
4. Principles of Lasers, O. Svelto, Plenum (1989)
5. Laser Physics, L.V. Tarasov, Mir (1983)
6. Laser: Theory & Applications, A. Ghatak & K. Tayagrajan, Macmillan India
7. Optical fibre communication (second edition) - Gerd Keiser, McGraw Hill, Inc. New York.
8. Optical fibres and fibre optic communication systems - S.Sarkar.

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-H4

Session: 2023-24	
Part A - Introduction	
Subject	Physics
Semester	8th
Name of the Course	Quantum Mechanics-II
Course Code	B23-PHY-801
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC
Level of the course (As per Annexure-I	400-499
Pre-requisite for the course (if any)	Appeared or passed the 7th Sem (B.Sc. Physical Science with Physics as major subject)
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Formulate perturbation, variational and WKB methods for obtaining approximate solutions of the Schrödinger equation, and apply these to simple physical situations. Comprehend on how perturbation can remove the degeneracy, particularly explanation of the Zeeman and Stark effects. 2. Use the WKB method to understand tunneling through a barrier and the alpha decay process. Apply the time-dependent perturbation theory to deal with atom-em radiation interaction and calculate explicitly the transition probability for the induced absorption and emission processes. 3. Explicate the electronic structure of many-electron atoms in central-field approximation, and estimate the central potential using the Thomas-Fermi and Hartree methods. Have an understanding of the nature of molecular energy levels, and calculate these for diatomic molecules. 4. Grasp the basics of non-relativistic quantum scattering theory, and learn the partial waves and Green's function methods for deriving scattering cross-sections. Calculate and analyze scattering cross-sections for finite square well, hard sphere and screened Coulomb potentials.

Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

Part B-Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Approximate methods for bound states-I:** Stationary perturbation theory: Non-degenerate case- First-order and second-order corrections to energy eigenvalues and eigenfunctions, Perturbation of an oscillator (harmonic and anharmonic ($ax^3 + bx^4$) perturbations), Ground state of Helium atom; Degenerate case- Removal of degeneracy in first and second order, Zeeman effect without electron spin, First-order Stark effect in n=2 state of Hydrogen, Fine structure of hydrogen atom (Relativistic and spin-orbit coupling corrections); Rayleigh-Ritz variational method: Ground and excited states, Application to ground state of Helium, Van der Waals interaction using perturbation and variational methods.	15
II	**Approximate methods for bound states-II:** The WKB approximation: Classical limit, Approximate solutions, Asymptotic nature of the solutions, Solution near a turning point, Linear turning point, Connection at the turning point, Asymptotic connection formulae, Application to energy levels of a quantum well, tunneling through a potential barrier and alpha decay; First-order time-dependent perturbation theory, Transition probability for constant and harmonic perturbations, Transition to a group of final states- The Fermi golden rule, Applications: Ionization of a hydrogen atom, Ionization probability, Interaction of an atom with em radiation (semi-classical treatment), Transition probability for induced absorption and emission, perturbation theory in scattering problems.	15
III	**Selected applications of Quantum Mechanics:** Atomic structure of many-electron atoms: Central-field approximation, Periodic system of	15

	elements, Thomas-Fermi statistical model, Evaluation of the potential, Hartree's self-consistent fields and connection with the variational method, Corrections to the central-field approximation, L-S and j-j couplings; Molecular structure: Classification of energy levels, Wave equation; The Hydrogen molecule: Potential energy function, The Morse potential, Rotation and vibration of diatomic molecules, Energy levels.	
IV	**Quantum theory of scattering:** Scattering experiments and cross-sections, The laboratory and centre-of-mass systems, Scattering amplitude and cross-section; The method of partial waves: Phase shift, Differential and total cross-sections, Relation between phase shift and scattering potential, Convergence of the partial-wave series, Scattering by a finite square well, Resonances- Breit-Wigner formula, Scattering by a hard-sphere potential; Green's function method: Lippmann-Schwinger equation, The Born series, The first Born approximation, Scattering of an electron by a screened Coulomb potential in Born approximation and validity criterion; Scattering of two identical spinless bosons, and spin-1/2 fermions.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination : 70 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Quantum Mechanics (3rd edition) by L. I. Schiff
2. Quantum Mechanics (2nd edition) by B. H. Bransden and Joachain
3. Introduction to Quantum Mechanics (2nd edition) by David J. Griffiths
4. Quantum Mechanics by A. K. Ghatak and S. Loknathan
5. A Textbook of Quantum Mechanics by P. M. Mathews and K. Venkatesan
6. Quantum Mechanics by John L. Powell and B. Crasemann
7. Quantum Mechanics: Concepts and Applications (2nd edition) by N. Zettili

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-H5

Session: 2023-24	
Part A - Introduction	
Subject	Physics
Semester	8th
Name of the Course	Nuclear and Particle Physics
Course Code	B23-PHY-802
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC
Level of the course (As per Annexure-I	400-499
Pre-requisite for the course (if any)	Appeared or passed the 7th Sem (B.Sc. Physical Science with Physics as major subject)
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the energy loss processes of different energetic particles in a medium and mechanisms of interaction of gamma photon with matter and to learn about the basic properties and characteristics of nuclear forces, and their mediating particles. 2. Know and learn about various types of detectors used in nuclear physics experiments, unique properties of different detectors and their applications in the field of nuclear physics. To Differentiate between different types of nuclear reactions, relevant aspects associated with nuclear reactions and kinematics of such reactions. 3. Describe certain properties associated with nuclei, models governing different aspects of nuclear behaviour and detailed understanding of deuteron problem and to understand the phenomenon of radioactive decays of alpha and beta particles, their detailed formalism. 4. Know about different elementary particles, their quark content and quark model and to learn about decay of some elementary particles and laws governing such decays.

Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

PartB-Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Radiation Interaction and Nuclear Forces:** Interaction of Charged Particles with Matter: qualitative description of various energy loss mechanisms, their relative contribution in case of heavy ions and electrons, classical stopping power equation for electronic energy-loss (no derivation) with significance of various terms involved, behavior of electronic energy-loss curve as a function of ion velocity, concept of energy straggling and range straggling and their correlation; Interaction of Gamma Radiation with Matter: features of photoelectric, Compton and pair production processes. **Nuclear Forces:** experimental evidence of charge symmetry and charge independence of nuclear forces, concept of isospin, Meson theory of nuclear forces, relationship between the range of the force and mass of the mediating particles.	15
II	**Radiation Detectors and Nuclear Reactions:** Gamma Ray Spectrometer: basic principle and working of NaI(Tl) scintillation detector, mechanism of pulse formation, basic idea of pulse processing unit, concept of energy resolution and efficiency of detector and its applications; Semiconductor Detectors: basic principle, construction and working and applications of Si surface barrier detector, high purity germanium detector. **Nuclear Reactions:** types of nuclear reactions, Q-value of a nuclear reaction and its determination, definition of cross section and its significance, elementary idea of compound nuclear reactions and direct reactions. concept of neutron detection, Coulomb excitation, nuclear kinematics.	15

III	**Nuclear Properties and Radioactive Decays:** Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model, Deuteron problem; Ground state of deuteron, Magnetic moment and its importance in the determination of exact ground state of deuteron. **Radioactive Decays:** energetics of alpha decay, tunnel theory of alpha decay, energetics of beta decay, Fermi theory of allowed beta decay, importance of Fermi-Kurie plot, parity non-conserving property of neutrino.	15
IV	**Particle Physics:** Units in high energy physics; Classification of particles-fermions and bosons, particles and antiparticles; Strange particles, Basic idea of different fundamental types of interactions with suitable examples; Quark flavors and their quantum numbers, Quarks as constituents of Hadrons, Qualitative idea of Quark confinement and asymptotic freedom, necessity of introducing the Color quantum no., Quark model, decay of pion and muon, Gell-Mann Nishijima formula, conservation laws.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination : 70 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Experimental Nuclear Physics by R. M. Singru.
2. Elements of Nuclear Physics by W. E. Meyerhof.
3. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy
4. Introduction to High Energy Physics (2nd edition) by D. H. Perkins.
5. Radiation Detection and Measurement by G. F. Knoll.
6. Nuclear Physics Theory and Experiment, by R. R. Roy and B. P. Nigam.

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-H6

Session: 2023-24	
Part A - Introduction	
Subject	Physics
Semester	8th
Name of the Course	Solid State Physics-II
Course Code	B23-PHY-803
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC
Level of the course (As per Annexure-I	400-499
Pre-requisite for the course (if any)	Appeared or passed the 7th Sem (B.Sc. Physical Science with Physics as major subject)
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Analyze the structure of a crystalline solid in terms of lattice, basis and unit cell, and of a non-crystalline solid on the basis of pair-distribution function. Deduce the structure of a crystalline solid from an analysis of the XRD pattern and the theoretically calculated crystal structure factor. 2. Calculate the dispersion of lattice waves for crystals with mono- and diatomic basis, and understand the principle underlying its experimental measurement using neutron scattering. Acquire an understanding of the concept of phonon and use it to determine the lattice heat capacity in the Einstein and Debye models. 3. Learn the Bloch's theorem, its application to the KP model, solve the one-electron Schrödinger equation for a periodic potential to see the emergence of energy bands, and classify materials into conductors, semiconductors and insulators. Learn and apply the tight binding and Wigner-Seitz methods for calculating the energy bands. 4. Grasp important characteristics of superconductors, along with qualitative aspects of the BCS theory of superconductivity. Explain the flux quantization in a superconducting ring, and the DC and AC Josephson

	effects.		
Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**		**Time:3hrs**	

PartB-Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Crystal structure:** Recapitulation of basic concepts: Bravais lattice and Primitive vectors; Primitive, Conventional and Wigner-Seitz unit cells; Crystal structures and lattices with basis; Symmetry operations and fundamental types of lattices; Index system for crystal planes. Determination of crystal structure by diffraction: Reciprocal lattice and Brillouin zones (examples of *sc*, *bcc* and *fcc* lattices); Bragg and Laue formulations of X-ray diffraction by a crystal and their equivalence; Laue equations; Ewald construction; Brillouin interpretation; Crystal and atomic structure factors; Structure factor of the *bcc* and *fcc* lattices, Examples of NaCl and diamond; Experimental methods of structure analysis: Types of probe beam, The Laue, rotating crystal and powder methods. Non-crystalline solids: Diffraction pattern; Monatomic amorphous materials; Pair-distribution function.	15
II	**Lattice dynamics and thermal properties:** Binding in solids: Crystals of inert gases, Lennard-Jones potential; Qualitative idea of Ionic, Covalent and Metallic bonding. Classical theory of lattice vibration (in harmonic approximation): Vibrations of crystals with monatomic basis- Dispersion relation, First Brillouin zone, Group velocity; Two atoms per primitive basis- dispersion of acoustical and optical modes. Quantization of lattice waves: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons. Thermal properties: Lattice (phonon) heat capacity; Normal modes; Density of states in one and three dimensions; Models of Debye and Einstein; Effects due to anharmonic crystal interactions; Thermal	15

	expansion; Thermal conductivity.	
III	**Electronic properties of solids:** Failure of the free electron gas model; Band theory of solids: Nearly free electron model, Energy gap; Periodic potential and Bloch's theorem; Kronig-Penney model; Wave equation of electron in a periodic potential, Solution of the central equation, Approximate solution at and near a zone boundary; Periodic, extended and reduced zone schemes of energy band representation; Number of orbitals in a band; Classification into metals, semiconductors and insulators. Calculation of energy bands: Tight binding method and its application to *sc* and *bcc* structures; Wigner-Seitz method, Cohesive energy; Pseudo-potential methods (qualitative idea only).	15
IV	**Superconductivity:** Experimental survey: Superconductivity and its occurrence, Destruction of superconductivity by magnetic fields, Meissner effect, Type I and type II superconductors, Entropy, Free energy, Heat capacity, Energy gap, Microwave and infrared properties, Isotope effect; Theoretical survey: Thermodynamics of the superconducting transition, London equation, Coherence length; Microscopic theory: Qualitative features of the BCS theory, BCS ground state wave function; Quantitative predictions of the BCS theory, critical temperature, energy gap, critical field, specific heat; Flux quantization in a superconducting ring; DC and AC Josephson effects; Macroscopic long-range quantum interference; High T_c superconductors (introduction only).	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination : 70 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Solid State Physics (7^{th} edition) by Charles Kittel
2. Solid State Physics by Neil W. Ashcroft and N. David Mermin
3. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
4. Principles of the Theory of Solids (2^{nd} edition) by J. M. Ziman
5. Condensed Matter Physics by Michael P. Marder
6. Applied Solid State Physics by Rajnikant

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-7/ DSE-H2

Session: 2023-24			
PartA - Introduction			
Subject	Physics		
Semester	8th		
Name of the Course	Electronic Devices and Circuits-II		
Course Code	B23-PHY-804		
CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	DSE		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (ifany)	Appeared or passed the 7th Sem (B.Sc. Physical Science with Physics as major subject)		
CourseLearningOutcomes (CLO):	After completing this course, the learner will be able to: 1. Well acquainted with the basic structures, operations, characteristics and biasing schemes of various field effect transistors.Understand the operations of different multivibrator circuits. 2. Develop a clear understanding of the basics of OPAMPS, its operating modes, internal structure and its vital design parameters. Become familiar with the basic structure, operation, characteristics and important applications of negative resistance devices. 3. Design and describe the operations of various families of logic gates. Simplify involved Boolean expressions with the help of Boolean algebra and K-map. 4. Explain the construction, operation, characteristics and important technological applications of various photonic devices. Explain the construction, operation, characteristics and important technological applications of different temperature sensitive devices.		
Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**	**Time:3hrs**

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Field Effect Transistors and Multivibrators:** Basic structure and operation of JFET, calculation of pinch off voltage, V-I characteristics of JFET, the FET small signal model, metal oxide semiconductor field effect transistor (MOSFET), physical structure, operation and characteristics, enhancement and depleted modes of operation, metal semiconductor field effect transistor (MESFET), low frequency common source and common drain FET amplifiers, FET biasing, FET as a voltage variable resistor (VVR). **Multivibrators:** a fixed biased transistor, a self-biased transistor and direct connected bistable multivibrator circuits, Schmitt trigger circuit, triggering techniques for bistable multivibrators, collector-coupled and emitter-coupled monostable and astable multivibrators.	16
II	**OPAMPs and Negative Resistance Devices**: The basic OPAMP, inverting and non-inverting mode of operation of OPAMP, effect of negative feedback on input and output resistances of OPAMPs, the differential amplifier, common mode rejection ratio (CMRR), the emitter coupled differential amplifier, the transfer characteristics of a differential amplifier, an IC OPAMP (MC-1530 Motorola) and its dc analysis, offset voltages and currents, universal balancing techniques, measurement of OPAMP parameters; basic working principles, characteristics and applications of uni-junction transistor (UJT), four layer diode (pnpn-diode), tunnel diode and silicon controlled rectifier.	15
III	**Digital Circuits:**Digital (binary) operation of a system, logic systems, the OR gate, the AND gate, the NOT gate, the exclusive OR gate, De Morgan's laws, Boolean algebra, the NAND and NOR diode-transistor gates, Modified DTL gates, fan-in and fan-out, wired logics, high threshold logic (HTL) gates, transistor- transistor logic (TTL) gates, output stages for TTL gates, resistance-transistor logic (RTL) gates, direct coupled transistor logic (DCTL) gates, emitter coupled logic (ECL) gates, digital MOSFET circuits, complementary MOS (CMOS) logic gates, comparison of logic families, Karnaugh- map (K-map) up to four variable	15

	and its applications.	
IV	**Optoelectronic and Temperature Sensing Devices:** Radiative and nonradiative transitions, basic construction, operation, characteristics and applications of solar cells, light dependent resistance (LDR), photodiodes, p-i-n diodes, metal semiconductor photodiodes, avalanche photodiodes, light emitting diodes (LEDs), semiconductor diode lasers, photo transistors, resistance thermometers, thermocouples and thermistors.	14
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**		**End Term Examination : 70 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Integrated Electronics by J. Millman and C. C. Halkias 2. Pulse, digital and switching waveforms by J. Millman and H. Taub 3. Electronic devices and circuits by Y. N. Bapat 4. Microwave devices and circuits by Samuel Y. Liao 5. Physics of semiconductor Devices by S. M. Sze 6. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick 7. OPAMPs and linear IC circuits by Ramakant A. Gayakwad 8. Electronics for Scientists and Engineers: Devices, Circuits and Systems by TV Viswanathan, GK Mehta and V Rajaraman		

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: DSE-7/ DSE-H2

Session: 2023-24			
PartA - Introduction			
Subject	Physics		
Semester	8th		
Name of the Course	Astrophysics		
Course Code	B23-PHY-805		
CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	DSE		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (ifany)	Appeared or passed the 7th Sem (B.Sc. Physical Science with Physics as major subject)		
CourseLearningOutcomes (CLO):	After completing this course, the learner will be able to: 1. Understand basic terminology of astronomy and astrophysics and sources of astronomical information. 2. Describe the stellar structure by employing simple stellar models. 3. Demonstrate the understanding of different stages of a star during its evolution. 4. Learn the role of various nuclear reactions in the process of energy production and nucleosynthesis in stars.		
Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**		**Time:3hrs**	

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Basics of Astrophysics**: Mass, length and time scales in astrophysics, Celestial coordinates, Magnitude scale, Electromagnetic radiation as a source of astronomical information: optical astronomy, radio astronomy, X-ray astronomy, Determination of mass, luminosity, radius, temperature and distance of a star, H-R Diagram, H-R Diagram of Clusters, Empirical mass-luminosity relation.	14
II	**Stellar Structure:** Basic equations of stellar structure:hydrostatic equilibrium in stars, Virial theorem for stars, energy transport inside stars, convection inside stars, Stellar observational data: determination of stellar parameters, Simple stellar models: polytropic model, the Chandrasekhar mass, the Eddington luminosity, Eddington's model, the point-source model.	15
III	**A Schematic Picture of the Evolution of Stars:** Characterization of the (log T, log ρ) plane: zones of the equation of state, zones of nuclear burning, zones of instability, The evolutionary path of the central point of a star in the (log T, log ρ) plane, The evolution of a star as viewed from its centre, The theory of the main sequence, Outline of the structure of stars in late evolutionary stages, Shortcomings of the simple stellar evolution picture.	15
IV	**Nuclear Processes in Stars:** The possibility of nuclear reactions in stars, Calculation of nuclear reaction rates, Important nuclear reactions in stellar interiors: hydrogen burning I: the p – p chain, hydrogen burning II: the CNO bi-cycle, helium burning: the triple-α reaction, Carbon and oxygen burning, Silicon burning: nuclear statistical equilibrium, Creation of heavy elements: the s- and r-processes.	16

SuggestedEvaluationMethods

InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination : 70 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Astrophysics for Physicists, Arnab Rai Choudhuri, Cambridge University Press, 2010
2. An Introduction to the Theory of Stellar Structure and Evolution, Dina Prialnik, Cambridge University Press, 2010
3. Stellar Interiors - Physical Principles, Structure, and Evolution, C. J. Hansen, S. D. Kawaler, V. Trimble (Springer, 2004)
4. Stellar Structure and Evolution, R. Kippenhahn and A. Weigert (Springer, 1996)
5. An Introduction to the Study of Stellar Structure, S. Chanrdrasekhar (Dover, 1968)
6. Textbook of Astronomy & Astrophysics, V. B. Bhatia (Narosa, 2001)
7. Observational Astrophysics, P. Lena (Springer, 1986)
8. Astrophysical Techniques, C.R. Kitchin (CRC press, 1995)
9. Astronomical Photometry, A. A. Henden & R.H. Kaitchuk (Willmann-Bell, 1990)
10. Astronomical Spectroscopy, C.R. Kitchin (IOP, 1995)

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: PC-H2

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">8th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Practicum Course</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-806</td></tr>
<tr><td>CourseType:
(CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">PC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">400-499</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Appeared or passed the 7th Sem (B.Sc. Physical Science with Physics as major subject)</td></tr>
<tr><td>CourseLearningOutcomes (CLO):</td><td colspan="3">After successful completion of the course on Physics Laboratory-I (general physics), a student will be able to:
1. Measure the width of a narrow slit using diffraction phenomenon and ionization potential of mercury. Also calculate the Planck’s constant using a suitable light source and half life of Indium.
2. Measure the mass absorption coefficient of β-rays in Aluminum and the band gap of a semiconductor and set Michelson and Fabry-Parot interferometers for various practical measurements.
3. Determine the strength of α-source and verify nuclear statistics using SSNTD. Also verify the energy quantization using the Frank-Hertz Experiment.
4. Demonstrate different harmonics present in complex signals using Fourier Analysis and understand the underlying dynamics mimicked by the Feigenbaum and the Chua’ circuits.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>-</td><td>4</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>-</td><td>8</td><td>8</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks:70</td><td colspan="2">Time: 4hrs</td></tr>
</table>

PartB-Contentsofthe Course

Instructions for Practical Examiners

1. Student will perform at least 08 experiments.
2. The examiner will allot one practical at the time of end term examination.

	Practicum 1. To measure the width of a narrow slit using the diffraction phenomenon. 2. To determine the ionization potential of mercury. 3. To determine the value of Planck's constant using photocell/LED 4. To study absorption of β-rays in Aluminum. 5. Michelson interferometer experiment 6. Fabry-Parot interferometer experiment. 7. To determine the half-life of Indium. 8. To determine the strength of an α-source using SSNTD. 9. To study nuclear statistics using SSNTD 10. Demonstration of energy quantization using the Frank-Hertz Experiment. 11. Fourier analysis of complex signals. 12. To determine band-gap of a semiconductor material. 13. To study nonlinear dynamics using Feigenbaum circuit. 14. To study nonlinear dynamics using Chua' circuit.	120

SuggestedEvaluationMethods

InternalAssessment: ➢ **Practicum (30 Marks)** • Class Participation: **05 Marks** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **15 Marks**	**End Term Examination : 70 Marks**

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Quantum Mechanics: Concepts and Applications (2nd edition) by N. Zettili
2. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
3. Phototubes, John F. Ryder
4. Nuclear Radiation Detectors, S.S. Kapoor and V.S. Ramamurti
5. Radiation detection and measurements, G.F. Knoll
6. Solid State Nuclear Track Detectors, S.A. Durrani
7. Techniques for Nuclear and Particle Physics Experiments, W.R. Leo

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-HM2

Session: 2023-24			
PartA - Introduction			
Subject	Physics		
Semester	8th		
Name of the Course	**Nanoscience and Nanomaterials**		
Course Code	B23-PHY-808		
CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	CC-M		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (ifany)	Appeared or passed the 7thsem (B.Sc. Physical Science (H)/ equivalent)		
CourseLearningOutcomes(CLO):	After completing this course, the learner will be able to: 1. Able to understand the Vision and objective of Nano-technology, Nanoparticles, Nanowires and Nanotubes, Nanolayers/Nanocoatings, Nanoporous Materials; Properties of Nanomaterials and Significance of Nanoscience. 2. Describe the Inorganic Natural Nanomaterials, Natural Nanomaterials from Animal Kingdom and Cell Walls. 3. Understand the basic Physics of methods for preparation ofNanomaterials/nanostructures. 4. Learn the application and advantages ofNanomaterials		
Credits	Theory	Practical	Total
	4	-	4
Contact Hours	4	-	4
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks:70**		**Time:3hrs**	

PartB-Contentsofthe Course

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Introduction:** Nanometers, Micrometers, Millimeters, Moore's Law, Nanoscale Elements in Traditional Technologies, Esaki's Quantum Tunneling Diode, Quantum Dots of Many Colors, Accelerometers in Car, Nanopore Filters, Historical Perspective, Vision and objective of Nano-technology, Nanomaterials: Nanoparticles, Nanowires and Nanotubes, Nanolayers/Nanocoatings, Nanoporous Materials; Properties of Nanomaterials, Significance of Nanoscience, Top down and Bottom up approach, Surface to Volume Ratio, Quantum confinement, Size effect in nano system.	15
II	**Natural Nanomaterials:** Nanomaterials All around Us, Aesthetic and Practical Value of Natural Nanomaterials, Learning from Natural Nanomaterials, the Nano Perspective. **Inorganic Natural Nanomaterials:** Minerals, Clays, Natural Carbon Nanoparticles, Nanoparticles from Space, Different Allotropes of carbon, Introduction to CNTs, Structure of CNTs, Types of CNTs- SWNTs, MWNTs, Bucky balls (C60), Graphene, Methane CH_4, Ethane C_2H_6, and Octane C_8H_{18}, Ethylene C_2H_4, Benzene C_6H_6, and Acetylene C_2H_2, Si Nanowire **Nanomaterials from the Animal Kingdom**: Building Blocks of Biomaterials, Shells, Exoskeletons, Endoskeletons, Skin and Its Extensions **Nanomaterials Derived from Cell Walls:** Paper, Cotton, Bacterial Fibers, Diatoms, Lotus Flower,	15
III	**Synthesismethods for Nanomaterials/Nanostructures:**Bottomupandtopdownapproachesforsynthesisof nanomaterials,Synthesis of zero-dimensional nanostructures (Nanoparticles):Sol-GelProcess,Epitaxial core-shellnanoparticles,Ballmilling,Synthesis of One-dimensionalnanostructures (Nanowires,Nanorods,Nanotubes):Electrochemicaldeposition,Lithography, Synthesis of Two-dimensional nanostructures (Thin Films & Quantum wells): Molecular beam epitaxy (MBE),MOCVD,Clusterbeamevaporation,Ionbeamdeposition.	15

IV	**Applications of Nanomaterials:** Importance of nano-scale and technology, Applications of Nanotechnology in different field: Automobiles, Electronics and Devices, Nano-biotechnology, Materials, Medicine, Food, Textiles and Fabrics, Sporting Equipment and Goods, Chemical and Bio sensor, biotechnology, Enhancing Water Quality, Space Science, Air Quality Improvement, IT sector, Environmental Remediation, Agriculture, Photoelectrochemical Cells; Advantages of Nanomaterials.	15
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (30 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **10 Marks** • Mid-Term Exam: **15 Marks**		**End Term Examination : 70Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Nanotechnologies: The Physics of Nanomaterials Volume I, David S. Schmool. 2. Introduction to Nanoscience, Gabor L Hornyak and Joydeep Dutta 3. Nanophysics and Nanotechnology, Edward L Wolf 4. Essentials in Nano-science and nanotechnology, Narendra Kumar, Sunit Kumbhat 5. Nanostructures & Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao 6. Nanotechnology: Principles and Practices, Sulabha K Kulkarni 7. Introduction to Nano: Basics to Nanoscience and Nanotechnology,Amretashis Sengupta and Chandan Kumar Sarkar.		

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-M5 (V)

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">3rd or 5th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Refrigeration and Air Conditioning</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-VOC-114</td></tr>
<tr><td>CourseType: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)</td><td colspan="3">VOC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">300-399</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Student of the 5thsem of any undergraduate scheme under NEP</td></tr>
<tr><td>CourseLearningOutcomes (CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Learn about the factors contributing to food spoilage, causes of food spoilage, methods of food preservation
2. Learn about the Commercial Applications of air-conditioning
3. Understand the principles of ice production, different methods of ice manufacturing
4. Learn about the Industrial Applications of air-conditioning.
5. Learn to present observations, results, analysis and different concepts related to refrigerators and air conditioners.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>2</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>2</td><td>4</td><td>6</td></tr>
<tr><td colspan="2">Max. Marks: 100
Internal Assessment Marks: 30
End Term Exam Marks:70</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
</table>

Instructions for Paper- Setter

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts.
4. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Food Preservation:** Introduction, factors contributing to food spoilage, causes of food spoilage, methods of food preservation, freezing method of food preservation, preservation of food with direct contact of liquid N_2, freeze drying, preservation of different products, cold storage and commercial cabinets	8
II	**Commercial Applications of air-conditioning:** Introduction, air-conditioning of houses, offices, hotels, restaurants, departmental stores, theatres, auditoriums, hospitals and medical stores.	7
III	**Ice-Manufacturing:** Introduction, principles of ice production, different methods of ice manufacturing, treatment of water for making ice, brines, freezing tanks, ice cans, quality of ice.	7
IV	**Industrial Applications of Refrigeration:** Introduction, importance of relative humidity in different industries, ice-cream manufacturing, refrigeration for breweries, selection of refrigerant for breweries, use of liquid N_2 for fabric, quality, air conditioning in textile and photographic industries.	8
	Practicum 1. To check and replace electrical components of refrigerator. 2. To check Common faults and their remedies in conventional refrigerator. 3. To install and inspect a new domestic refrigerator. 4. Checking door alignment & replacing gaskets. 5. To strip out defective compressor. 6. To clean and flush for contamination in condenser coil, evaporator coil of conventional refrigerator. 7. Evacuating, leakage testing and gas charging in refrigerator. 8. To check and test electrical accessories in frost free refrigerator. 9. Servicing of components of frost free refrigerator. 10. Identification the electrical and mechanical components of window air conditioner. 11. Servicing and maintenance of window air conditioner. 12. Leak testing in window air conditioner. 13. Evacuation and gas charging in window air conditioner. 14. Identifying various components of split air conditioner. 15. Leakage testing in split air conditioner.	60

	16. Evacuation and gas charging in split air conditioner. **Note: Student will perform at least eight experiments. The examiner will allot one practical at the time of end term examination.**	
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (15 Marks)** • Class Participation: **04 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**04 Marks** • Mid-Term Exam: **07 Marks** ➢ **Practicum (15 Marks)** • Class Participation:**05** • Seminar/Demonstration/Viva-voce/Lab records etc.:**10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 35 Marks** **: 35 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House 2. Refrigeration and Air Conditioning by C.P.Arora, McGraw Hill education (India) (P) limited, New Delhi 3. Principles of Refrigeration by Roy J. Dossat, Pearson education, New Delhi 4. Refrigeration and Air Conditioning by Manohar Prasad, New age international (P) limited, New Delhi 5. Course in Refrigeration and Air Conditioning by S.C.Arora and S.Domkundwar, Dhanpatrai and sons, Delhi		

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-M7 (V)

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">6th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Maintenance of Laboratory Instruments</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-VOC-322</td></tr>
<tr><td>CourseType: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)</td><td colspan="3">VOC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">300-399</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Student of the 6thsem of any undergraduate scheme under NEP</td></tr>
<tr><td>CourseLearningOutcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand the standard operating procedure related to Physics Laboratory.
2. Understand the Maintenance of Electronics experiment
3. Understand the Maintenance of mechanics experiments
4. Understand the Maintenance of optics experiments
5. Able to design the basic electronic circuits using diodes and transistors and analyze their input/output.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>2</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>2</td><td>4</td><td>6</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks:70</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter</u>
1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from</td></tr>
</table>

each unit. Each question may contain two or more parts.

4. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Standard Operating Procedure for Maintenance of Lab Equipment, safety rules and policies, culture of laboratory safety, responsibility and accountability for laboratory safety, special safety considerations in Physics Lab, other factors that influence laboratory safety programs,	7
II	Equipment Maintenance Documentation, Maintenance of Electronics experiment, Symbols, Terminal identification, applications of various semiconductor devices- Diodes, Transistors, SCR and UJT, Introduction to voltage regulator, types of regulators, CRO and GM Counter.	8
III	Maintenance of equipment's of mechanics: Basicterms and maintenance of Vernier Caliper, Screw Gauge, Spherometer, Fly wheel, Bar pendulum, Torsion pendulum, Jaeger apparatus, Barometer and Maxwell Needle.	8
IV	Maintenance of equipment's of optics: Basic terms and maintenance of sextant, lasers, spectrometer, sodium lamp, mercury lamp, travelling microscope, Fresnel Biprism and optical bench.	7
	Practicum 1. Maintenance of electrical instruments. 2. Maintenance of optical instruments. 3. Maintenance of mechanical instruments. 4. To study the construction and functioning of CRO. 5. To design sawtooth wave generator using UJT. 6. To design and check the half wave rectifier circuit. 7. To design and check the full wave rectifier circuit. 8. To design voltage regulator circuit using Zener diode and find line and load regulation. 9. To design CE amplifier circuit. 10. To design CB amplifier circuit. **Note: Student will perform at least eight experiments. The examiner will allot one practical at the time of end term examination.**	60
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (15 Marks)** • Class Participation: **04 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**04 Marks** • Mid-Term Exam: **07 Marks** ➢ **Practicum (15 Marks)** • Class Participation:**05** • Seminar/Demonstration/Viva-voce/Lab records etc.:**10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 35 Marks** **: 35 Marks**

PartC-Learning Resources
Recommended Books/e-resources/LMS: 1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi 2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi 3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi 4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut 5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar 6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Kurukshetra University Kurukshetra
Undergraduate Programs
Course: CC-M7 (V)

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">6th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Installation and Maintenance of Solar Panels</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-VOC-323</td></tr>
<tr><td>CourseType: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)</td><td colspan="3">VOC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">300-399</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">Student of the 6thsem of any undergraduate scheme under NEP</td></tr>
<tr><td>CourseLearningOutcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand the basics of solar energy and solar panels
2. Learn about the SPV Panels systems and their Installation
3. Get the knowledge about the testing methods and techniques SPV.
4. Learn about Maintenance and Troubleshooting process of SPV.
5. Learn to present observations, results, analysis and different concepts related to solar photo voltaic systems.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>2</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>2</td><td>4</td><td>6</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks:70</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter</u>
1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.</td></tr>
</table>

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts.
4. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Introduction to solar energy and solar panels:** Solar Energy and its potential, Harnessing solar energy, need for Solar energy to electrical energy conversion, Solar photo voltaic (SPV) system, SPV panels and their types, ratings and specifications. Advantages and disadvantages of SPV panels, basics of load calculation and SPV requirement	7
II	**SPV Panels systems:** Solar panel to SPV systems: OFF grid and ON grid solar systems, Areas of applications of SPV systems, components of solar systems; solar panel, inverter (Stand alone and grid tied), Battery Energy system (BES), Charge controller, **Tools and equipments**: Digital Multimeter Clamp Meter Hydrometer, Sun pathfinder Thermography Camera, drills and fasteners, sealents, pliers and strippers, Pyranometer, Personal Protective Equipments (PPE), Battery maintenance kit Battery water filler etc.	8
III	**Installation of SPV Panels**: Site selection criteria, steps and procedure for solar panel array installation, different mounting structures, installation of AC and DC distribution boxes, earthing and grounding pits, optimal cable sizing and cable laying. **Testing and Inspection:** Testing methods and techniques, testingof SPV open circuit and load voltage, Battery SOC testing, testing of protective systems and earth resistance, Inspection of connected systems and running a test.	8
IV	**Maintenance and Troubleshooting:** Scheduled and unscheduled maintenance, checking dust accumulation, Module Shading Module Mismatch, Physical Integrity, standard trouble shooting procedure.	7
	Practicum 1. To study the various components of A Residential Solar Electric System. 2. To study the Series and Parallel Connection in Solar system. 3. To study the various Parameters in Solar Panel Installations. 4. To study the Solar energy system components used in the Installation of solar panel 5. To study the solar tracking system. 6. Measurement of PV module parameters andstudy of their characteristics. 7. Testing of Standalone PV system 8. To Measure voltage, current and power of solar photovoltaic modules 9. Identify the components of solar photovoltaic system 10. Identification of types of solar photovoltaic systems 11. Define solar cell parameters List the types of connections of solar	60

	photovoltaic panel 12. Identify the batteries used in PV system and describe standard parameters of battery. 13. Recognize functions of a charge controller 14. Identify prerequisites for installing a solar PV system. **Note: Student will perform at least eight experiments. The examiner will allot one practical at the time of end term examination.**	
SuggestedEvaluationMethods		
InternalAssessment: ➢ **Theory (15 Marks)** • Class Participation: **04 Marks** • Seminar/presentation/assignment/quiz/class test etc.:**04 Marks** • Mid-Term Exam: **07 Marks** ➢ **Practicum (15 Marks)** • Class Participation:**05** • Seminar/Demonstration/Viva-voce/Lab records etc.:**10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 35 Marks** **: 35 Marks**
PartC-Learning Resources		
Recommended Books/e-resources/LMS: 1. Solar Photovoltaic technology PHI 2013, Chetan Singh Soalnki 2. Solar Electrical Handbook 2021, Michael Boxwell 3. Handbook for rooftop solar panel installation in Asia, 2014 Asian Development Bank (ADB)		