Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY501	**Title of the Course**	**Atomic and Molecular Physics**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	3rd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart advance knowledge of atomic and molecular physics to obtain quantitative and qualitative analysis in the field of spectroscopy for higher studies. After successful completion of course, the student will be able explore subject into their respective dimensions.						

Course Outcomes	
CO1	To obtain the quantum mechanical solution of hydrogen and hydrogen-like atoms and analyze the spectra of alkali atoms.
CO2	To obtain the quantum mechanical solution of many-electron under different approximations thereby evaluate spectroscopic terms under LS and JJ coupling schemes.
CO3	Evaluate and analyse the Pure- Rotational spectra, Rotational-vibrational spectra and electronic spectra of diatomic molecules.
CO4	To investigate the energy spectrum of mono, dia or poly-atomic molecules using different spectroscopic technique.
CO5	To understand and contrast the working of different spectroscopes.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Atomic Physics-I	Quantum Mechanical Treatment of one-electron Atom, Spin-Orbit interaction and fine structure of hydrogen atom, Spectra of alkali elements. Singlet and triplet States of Helium.	08	1
2	Atomic Physics-II	Many electron atoms: Central field approximation, Thomas-Fermi field, Atomic wave function, Hartree and Hartree–Fock approximations, Spectroscopic Terms: L S and J J coupling schemes for many electron atoms, wave functions and energies of multiplets, Electric dipole and Electric Quadrupole.	08	2
3	Molecular Physics	Born-Oppenheimer approximation, Heitler-London theory of H_2, LACO treatment of $H_2^+$and H_2. Classification of Molecules, Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra, Raman Scattering, Selection rules, Nuclear spin and intensity alternation, Isotope effect, Classification of electronic states, Coupling of rotational and electronic motions, Electronic spectra: Franck-Condon principle.	08	3
4	Molecular Physics	Infrared Spectroscopy, Raman spectroscopy, Photoelectron Spectroscopy, Nuclear Magnetic Resonance, Chemical Shift, and Electron Spin Resonance (Introduction and their principles only).	08	4
5	Spectroscopic Techniques	General description and working of infra-red Spectrophotometer, Photoelectron Spectrometer, Simple Raman Spectrometer, NMR Spectrometer and ESR Spectrometer.	08	5

Reference Books:

1. Introduction to atomic spectra by H.E. White
2. Spectra of diatomic molecules by Herzberg
3. Atoms and molecules by M. Weissbluth
4. Quantum theory of Atomic Structure Vol I by Slater
5. Quantum theory of molecules and Solids by Slater
6. Fundamentals of molecular spectroscopy by C. B. Banwell

e-Learning Source:

1. https://nptel.ac.in/courses/115101003/
2. https://nptel.ac.in/courses/115105100/
3. https://www.freebookcentre.net/physics-books-download/Atomic-and-Molecular-Physics-NPTEL.html

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**3**	**1**	**2**		**2**	**3**	**1**						**2**	**1**	**2**	**2**	**1**	**1**
CO2	**2**	**2**	**1**		**1**	**1**	**3**						**2**	**1**	**2**	**2**	**1**	**1**
CO3	**3**	**1**	**2**		**3**	**2**	**1**						**1**	**1**	**2**	**2**	**1**	**1**
CO4	**2**	**2**	**1**		**2**	**1**	**1**						**3**	**1**	**1**	**1**	**3**	**1**
CO5	**3**	**1**	**2**		**3**	**1**	**3**						**3**	**1**	**2**	**1**	**3**	**1**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY502	**Title of the Course**	**Electronic Instrumentation**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	3rd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Basics of Electronics and measurement	**Co-requisite**					
Course Objectives	1. Build the strong background in the field of instrumentation and measurement. 2. To understand the basic concept of different types of filters and concepts of electronics communication. 3. To learn the basic concept of telemetry system, wave analyzer and CRO						

Course Outcomes	
CO1	Recognize the evolution and history of units and standards in Measurements.
CO2	Identify the various parameters that are measurable in electronic instrumentation.
CO3	Employ appropriate instruments to measure given sets of parameters.
CO4	Practice the construction of testing and measuring set up for electronic systems
CO5	To have a deep understanding about instrumentation concepts which can be applied to Control systems.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Signal representation & generation	Periodic signals, modulated signals (A.M.F.M.P.M.), sampled data pulse Modulation PWM, PAM, PPM) definition and their graphical representation. Generation of sine, Square, triangular, linear ramp & saw tooth waveform.	08	1
2	Measurement of electrical signals	Meters: comparison of analog & digital meters, moving coil, moving iron, electrodynamics, Induction meter, clamp on meter. CRO: Block diagram of general purpose CRO, Detail study of CRT, Dual beam oscilloscope, How CRO displays waveform, various methods of measurement of voltage, current, resistance, frequency, phase, capacitance & inductance.	08	2
3	Signal Processing Circuit	Electronic amplifiers: Difference or balance amplifier, Operational amplifier, Instrumentation amplifier, Charge amplifier, Power amplifier. passive & active filters. Butter worth filter (low pass, High pass, band pass), Notch filter.	08	3
4	Data Acquisition conversion, processing & transmission system	General DAS, signal conditioning of inputs, single channel DAS multichannel DAS,R-2R ladder Network, successive approximation type ADC, Analog & digital multiplexer, Sample and hold Circuit. Data transmission system. Telemetry system Block diagram, Characteristics, Land line Telemetry, Radio telemetry, Processing system.	08	4
5	Applications of Electronic System	Frequency selective wave analyzer, Spectrum analyzer, Lock-in amplifier, Fiber optic sensors. Measurement of Humidity, Hygrometers, Measurement of pH, Measurement of thermal Conductivity (gas analyzer), Nuclear instrumentation-types of radiation, Geiger-Muller tube, ionization chamber. Flow meters: Classification, working principle, electromagnetic flow meter, Ultrasonic flow meter. Q Meter- principle, working & applications. DFM-Block diagram, principle & working. DMM Block diagram, principle & working.	08	5

Reference Books:

1. Transducers & Instrumentation: D. V. S. Murthy
2. Instrumentation-Devices & System: C. S. Rangan, G. R. Sharma, V. S. V. Mani
3. Principles of measurement and Instrumentation: Alan S. Morris
4. Electronic Instrumentation: Kalsi
5. Electrical & Electronic Measurement Instrumentation: A. K. Sawhney
6. Modern Electronic Instrumentation & Measurement Technique: Helfrick Coope

e-Learning Source:

1. https://nptel.ac.in/courses/108/105/108105153/
2. https://ocw.tudelft.nl/courses/electronic-instrumentation/
3. https://www.classcentral.com/course/swayam-electrical-measurement-and-electronic-instruments-14032
4. https://swayam.gov.in/nd1_noc19_ee44/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**3**	**2**	**2**	**1**	**3**	**2**	**1**						**1**	**2**	**2**		**2**	**1**
CO2			**3**	**2**	**2**	**1**							**3**		**2**	**2**	**1**	**3**
CO3	**3**				**2**	**1**								**2**	**1**	**3**	**3**	
CO4		**3**	**3**	**2**	**1**		**1**								**1**	**3**	**3**	**2**
CO5	**3**	**3**		**2**	**1**								**2**	**2**	**1**	**2**	**1**	**2**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY503	**Title of the Course**	**Advanced Condensed Matter Physics (Revised)**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	3rd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this course is to impart advance knowledge of condensed matters. With the help of various physics and mathematics laws the student will study a detailed study of various important phenomena of physics in condensed matter. After completion of the course, the student will be able to explore the subject in the field of research.						

Course Outcomes	
CO1	Students will gain an understanding of the various phenomena of dielectrics and ferroelectrics.
CO2	Students will learn about the Optical properties of materials.
CO3	Students will gain the knowledge about the various physics laws of magnetism and their quantum mechanical formulation.
CO4	Students will learn about the superconducting behaviour and its interpretation in materials.
CO5	Students will analyse and understand various types of defects in solids.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Dielectrics and Ferroelectrics**	Macroscopic electric fields, local field at an atom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, phase transition, piezoelectricity, ferroelasticity, electrostriction	08	1
2	**Optical Properties of Materials**	Optical constants, excitation across a gap Electronic interband and intraband transitions, relation between optical properties and band structure, photoluminescence, electroluminescence, screening, plasmons, polarons, excitons. reflectance	08	2
3	**Magnetism**	Origin of magnetism; Electric current in atoms (Bohr Magneton), Electron spin and magnetic moment , magnetic moment due to nuclear spin, theory of magnetism in electrons, types of magnetism, Diamagnetism(including Langevin's classical theory and quantum theory), Paramagnetism (Langevin's classical theory, Weiss theory and quantum theory), Ferromagnetism; classical theory Curie-Weiss law, temperature dependence and quantum theory, Antiferromagnetism	08	3
4	**Superconductivity**	Fundamental phenomena of superconductivity, Effect of magnetic field; Meissner effect, Electrodynamics of superconductors: London equation, Type I and type II superconductors, BCS theory: Electron-lattice-Electron interaction, Coopers pair and energy gap, Josephson Effect, SQUIDS.	08	4
5	**Atomic Imperfections in Solids**	Point imperfection in ionic crystals, Line imperfection, Edge and Screw dislocation, Burgers vector and Burger's circuit, Dislocation motion, Energy of dislocation, Slip planes and slip directions, Perfect and imperfect dislocations, Dislocation reaction, Surface imperfections, Grain boundary, Tilt and Twist boundary	08	5

Reference Books:

1. N.W. Ashcroft and N.D. Mermin, *Solid State Physics*
2. D. Pines, *Elementary Excitations in Solids*
3. S. Raimes, *The Wave Mechanics of Electrons in Metals*
4. P. Fazekas, *Lecture Notes on Electron Correlation and Magnetism*
5. M. Tinkham, *Introduction to Superconductivity*
6. M. Marder, *Condensed Matter Physics*

e-Learning Source:

1. https://nptel.ac.in/courses/115/103/115103102/
2. https://nptel.ac.in/courses/115/106/115106061/
3. https://nptel.ac.in/courses/115/101/115101009/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**3**	**2**	**1**		**2**	**3**	**3**						**1**	**3**	**2**	**2**	**3**	**3**
CO2	**2**	**3**	**2**		**3**	**1**							**2**	**1**	**1**	**1**	**3**	**3**
CO3	**2**	**1**	**3**		**3**	**2**	**1**						**2**	**1**	**1**	**1**	**3**	**3**
CO4	**3**	**2**	**1**		**1**	**1**							**3**	**3**	**2**	**2**	**3**	**3**
CO5	**2**	**1**	**2**		**2**	**2**	**2**						**1**	**3**	**2**	**2**	**3**	**3**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY504	**Title of the Course**	**Communication Electronics**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	3rd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart basic and key knowledge of communication through electronics system. This course also provides the knowledge of fundamental concepts and principles that are used to solve the communication electronics problem.						

Course Outcomes	
CO1	Students shall be able to understand about the functions of various microwave devices and its operation.
CO2	For the Amplitude modulated systems, student shall be able to understand the various types of modulation and its evaluation with applications.
CO3	Student shall be able to understand the basics of angle modulation in analog communication system and analysis of Parameter variation, FM and PM generation and reception.
CO4	Students shall be able to understand of the Transmission and Radiation of signals. They are able to calculate impedance, Smith Chart, standing wave ratio and measurements at radio frequencies
CO5	Student shall be able understand the sources of optical communication, optical receivers and optical fiber, Students are able to define S/N and effect of noise in the optical communication system.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Microwave Devices	Klystrons amplifiers, velocity modulation, Basic principles of two cavity klystrons, Multi-cavity klystron amplifier and Reflex klystron oscillator, Magnetrons, principles of operation of magnetrons and Travelling wave tube (TWT). Transferred electron devices, Gun effect, Principles of operations, modes of operation, Read diode, IMPATT diode, and TRAPATT diode.	08	1
2	Amplitude Modulated Systems	Frequency translation, method of frequency translation, recovery of the base band signal, Amplitude modulation, Maximum allowed modulation, The square law demodulation, Spectrum of an amplitude modulated signal, Modulators and Balanced modulators, Single side band modulation, Methods of generating as SSB signal, Vestigial side band modulation, Multiplexing.	08	2
3	Frequency Modulated Systems	Angle modulation, Phase and frequency modulation, Relationship between phase and frequency modulation, Phase and frequency deviation, Spectrum of an FM signal, Sinusoidal modulation, Bandwidth of a sinusoidally modulated FM signal, FM generation, Parameter variation method, Armstrong system.	08	3
4	Transmission and Radiation of Signals	Primary line constants, phase velocity and line wavelength, Characteristic impedance, Propagation Coefficient, Phase and group velocities, Standing waves, Lossless line at radio frequencies, Voltage standing wave ratio, Slotted line measurements at radio frequencies, Transmission lines as circuit elements, Smith chart, Single and double Stub matching, Time domain reflectometry, Telephone lines and cables, Radio frequency lines.	08	4
5	Fiber Optic Communication	Light sources for optical communication, Optical Receivers, Modes in Optical fiber, Optical communication system, Losses in fibers, Dispersion in fiber, Power Budgeting, S/N ratio, Effect of index profile on propagation, TDM, WDM.	08	5

Reference Books:

1. Electronic Devices and circuit Theory by R. Boylested and L.Nashelsky
2. Principles of Communication Systems by H. Taub and Donald L.Schilling
3. Optoelectronics: Theory and Practice, Edited by Alien Chappal
4. Microwaves by K.L.Gupta
5. Electronic communications by Dennis Roddy and John Coolen

e-Learning Source:

1. https://archive.nptel.ac.in/courses/117/105/117105130/
2. https://archive.nptel.ac.in/courses/117/104/117104127/
3. https://archive.nptel.ac.in/courses/117/105/117105149/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**2**	**1**	**2**		**2**	**3**							**2**	**2**				
CO2	**3**	**2**	**3**	**1**	**1**	**1**	**1**						**2**	**2**				
CO3	**1**	**3**	**2**	**1**	**2**	**3**	**2**						**2**	**2**				
CO4	**2**	**2**	**1**		**1**	**2**	**1**						**2**		**1**			
CO5	**3**	**1**	**2**	**1**	**2**	**1**							**2**		**1**			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY505	**Title of the Course**	**Numerical Techniques and Statistical Mechanics-II**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	3rd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is (1) to impart the knowledge of different mathematical tools required for the rigorous analysis of data and its interpretation (2) Advance concepts of physics of phase transitions. By using the principles of physics and mathematics, students will be able to obtain quantitative relations which are very important for higher studies. After successful completion of course, the student will be able explore subject into their respective dimensions.						

Course Outcomes	
CO1	Students will be able to analyze, interpret, perform error analysis and testing of data using different types of mathematical tools.
CO2	Students will be able to apply various types of numerical techniques to solve different mathematical problems.
CO3	Students will gain an understanding about the phase transition phenomenon and different theoretical explanation behind it.
CO4	Students will develop their understanding about the dynamical models of phase transitions.
CO5	Students will gain an understanding about the fluctuations in physical parameter when the system is slightly out of equilibrium and to apply advance mathematical tools to deal with such type of problems.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Numerical Analysis	Data interpretation and analysis, Precision and accuracy, Error analysis, propagation of errors, least square fitting, linear and nonlinear curve fitting, goodness of fit, chi-square test.	08	1
2	Statistical Techniques	Elements of computation techniques; root of functions, interpolation, extrapolation, Newton's forward and backward interpolation, Lagrange's interpolation formula, integration by trapezoidal and Simpson's rules, Solution of first order differential equation using Runge-Kutta method, Finite difference method, Lagrange's method of undetermined multipliers.	08	2
3	Phase Transitions and Critical Phenomena	Coexistence of phases, Gibb's phase rule, classification of phase transitions, critical phenomena and critical exponents, Landau theory, scaling hypothesis, universality classes phase transition of Vander Waal's gas, phase transition in liquid He, second, third and fourth sounds, Tisza two fluid model, Landau's spectrum of phonons and rotons.	08	3
4	Dynamical Models of Phase Transitions	Heisenberg model, mean-field theory, Ising model in 1D, exact solution in one dimension, renormalization in one dimension, order disorder transformation in alloys, structural phase change, lattice gas.	08	4
5	Non-equilibrium Systems and Time Correlation Functions	Systems out of equilibrium, approach to equilibrium and the H-theorem, thermodynamics of fluctuations, fluctuation-dissipation theorem, Fokker-Planck equation, Onsager relations, statistical correlation, correlation length, spatial and spin-spin correlation.	08	5

Reference Books:

1. K. Huang, *Statistical Mechanics*, John Wiley and Sons, 2nd Edition, 1987.
2. R.K. Pathria, *Statistical Mechanics*, Academic Press, 3rd Edition, 2011.
3. E.M. Lifshitz and L.P. Pitaevskii, *Physical Kinetics*, Pergamon Press, 2012.
4. D.A. McQuarrie, *Statistical Mechanics*, Harper and Row Publication, 2000.
5. L.P. Kadanoff, *Statistical Physics: Statistics, Dynamics and Renormalization*, World Scientific Press, 2000.

e-Learning Source:

1. https://nptel.ac.in/courses/115/106/115106091/
2. https://nptel.ac.in/courses/115/103/115103028/
3. http://www.math.wisc.edu/~shottovy/NumPDEreport.pdf
4. https://www.damtp.cam.ac.uk/user/tong/statphys/five.pdf

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	1	2	2	1	3						2	2	1	1	2	
CO2	3	1	1		3	1	3						3	1	3	2	1	
CO3	3	1	2		3	1	3						2	2	2	3	3	
CO4	3	1	2		2	1	3						2	1	3	2	1	
CO5	3	1	2		2	1	3						2	2	2	1	2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY506	**Title of the Course**	**Electronics Lab**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	3rd	**0**	**0**	**8**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives							

Course Outcomes	
CO1	Students shall be able to Learn, understand, design and verify the truth tables of combinational circuit.
CO2	Prepare professional quality textual and computational results, incorporating accepted data analysis and synthesis methods, simulation software, and word-processing tools.
CO3	Students shall be able to Learn, understand, design and verify the truth tables of Sequential circuit.
CO4	Students shall be able to Learn and understand the concepts of memory cell.
CO5	Students shall be able to write the Assembly language programming and shall be able to execute the program using 8085 kit.

Experiment No.	**Title of the Experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Temperature – Frequency Conversion**	Temperature to frequency conversion using a thermister and astable multivibrator circuit.	08	1
2	**OP-AMP 741**	Operational Amplifier characteristics using IC 741.	08	1
3	**IC 555 Timer**	Capacitance measurement using IC 555.	08	2
4	**Multiplexer – Demultiplexer**	Experiments on MUX, DEMUX, Decoder and shift register.	08	2
5	**Flip – Flop and Counter**	JK Flip-Flop and up-down counter.	08	3
6	**Optical Fiber**	Fiber optic communication.	08	3
7	**Analog to Digital Converter**	A/D converter interfacing and AC/DC voltage/current measurement using microprocessor 8085/8086.	08	4
8	**Serial Communication**	PPI 8251 interfacing with microprocessor for serial communication.	08	4
9	**Digital to Analog Converter**	D/A converter interfacing and frequency/temperature measurement with microprocessor 8085/ 8086.	08	5
10	**Programming of 8085/8086**	Program of 8085/ 8086 to solve a Boolean Equation which represents Combinational logic.	08	5

Reference Books:

1. Electronic Devices and Circuit Theory by R.L. Boylested and L. Nashelsky
2. Principles of Communication Systems by H. Taub and Donald L.Schilling
3. Electronic communications by Dennis Roddy and John Coolen
4. Optoelectronics: Theory and Practice, Edited by Alien Chappal

e-Learning Source:

1. https://nptel.ac.in/courses/108/105/108105153/
2. https://ocw.tudelft.nl/courses/electronic-instrumentation/
3. https://www.classcentral.com/course/swayam-electrical-measurement-and-electronic-instruments-14032
4. https://swayam.gov.in/nd1_noc19_ee44/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**3**	**3**	**3**	**3**		**2**	**1**						**3**	**1**	**2**	**3**	**2**	**1**
CO2	**2**	**2**	**1**	**1**			**2**						**2**	**2**	**1**	**1**	**2**	**2**
CO3	**3**	**1**	**3**	**3**		**2**	**2**						**2**	**1**	**2**	**3**	**1**	**2**
CO4	**1**	**3**	**3**	**1**			**3**						**1**	**1**	**2**	**1**	**2**	**3**
CO5	**3**	**2**	**2**	**2**		**3**							**2**	**3**	**1**	**2**	**3**	**1**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY509	**Title of the Course**	**Physics of Nanomaterials**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	4th	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart basic and key knowledge of Nanoscience and Nanomaterials. By using the principles of physics and mathematics, student will be able to learn the different techniques for the growth and characterization of nanomaterials. After successful completion of course, the student will be use these concepts in the field of research..						

Course Outcomes	
CO1	Students will gain an understanding of how the different manifestation of modern science and their interdisciplinary nature leads to a new technology which is applicable in various walks of life.
CO2	Students will be able to realize the importance of concepts of advance physics behind the development of a new theory.
CO3	Students will gain an understanding of new concepts of quantum confinement and evaluate its role in formation of quantum structures.
CO4	Students will learn about the different characterization techniques required for the properties estimation of materials at nanoscale.
CO5	Students will realize the key issues in the synthesis of nanomaterials and the different approaches used for their synthesis.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to Nanostructure Materials	Nanoscience and nanotechnology, Size dependence of properties, Moore's law, Surface energy and Melting point (quasi melting) of nanoparticles	08	1
2	Band Structure of Solids	Free electron theory (qualitative idea) and its features, Idea of band structure, insulators, semiconductors and conductors, Energy band gaps of semiconductors, Effective masses and Fermi surfaces, Localized particles, Donors, Acceptors and Deep traps, Mobility, Excitons, Density of states, Variation of density of states with energy and Size of crystal	08	2
3	Quantum Size Effect	Quantum confinement, Nanomaterials structures, Two-dimensional quantum system, Quantum well, Quantum wire and Quantum dot, Fabrication techniques.	08	3
4	Characterization Techniques of Nanomaterials	Determination of particle size, XRD (Scherrer's formula), Increase in width of XRD peaks of nanoparticles, Shift in absorption spectra peak of nanoparticles, Shift in photoluminescence peaks, Electron Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy (SPM), Scanning Tunneling Electron Microscopy (STEM), and Atomic Force Microscopy (AFM).	08	4
5	Synthesis of Nanomaterials	Key issue in the synthesis of Nanomaterials, Different approaches of synthesis, Top down and Bottom-up approaches, Cluster beam evaporation, Ball Milling, Chemical bath deposition with capping agent, Carbon nanotubes (CNT)-Synthesis, Properties and Applications.	08	5

Reference Books:

1. Nanostructures and Nanomaterials, Synthesis, Properties and Applications by Guozhong Cao, Imperial College Press
2. Introduction to Nanotechnology, by Charles P. Poole, Jr. Frank J. Owens, John Wiley and Sons Inc. Publication
3. Quantum Wells, Wires and Dots by Paul Harrison, John Wiley and Sons Ltd.
4. Introduction to Nanoscience and Nanotechnology by Hornyak G.L., Tibbals H.F., Dutta J., Moore J.J., CRC Press.
5. Carbon Nanotubes: Properties and Applications by Michael J. O'. Connell

e-Learning Source:

1. https://nptel.ac.in/courses/118/104/118104008/
2. https://nptel.ac.in/courses/118/102/118102003/
3. https://www.nanowerk.com/nanotechnology/introduction/introduction_to_nanotechnology_1.php

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	1	2	2	3	2						1	2	2	1	1	
CO2	1	2	2		2	1	3						2	1	3	2	2	
CO3	3	1	3		3	1	1						2		3		2	
CO4	2	3	1		2	2	3						3			1	3	
CO5	3	1	2	1	3	1	3						2	1		2	2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY512	**Title of the Course**	**Laser Physics**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	4th	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this course is to impart basic and key knowledge of lasers. With the use of various principles of Physics and Mathematics a deep understanding of laser rate equations will be explained to the students. The course will provide a detailed knowledge of various phenomena involved in the construction of lasers and their applications.						

Course Outcomes	
CO1	Students will gain an understanding of the basic principle, construction and functioning of a variety of lasers.
CO2	Students will be able to understand and solve the laser rate equations of two, three and four level lasers.
CO3	Students will be able to understand the functioning of various types of cavities involved in the construction of lasers stability, quality factor.
CO4	Students will gain an understanding of Coherence and Pulsed Operation and statistics of Lasers.
CO5	Students will learn about the various applications of lasers.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction	Masers versus lasers, components of a laser system, amplification by population inversion, oscillation condition, Lorentz theory, Einstein's rate equations, applications to laser transitions with pumping, two, three and four-level schemes, threshold pumping and inversion.	08	1
2	Atom-Field Interactions	Solid-state (Ruby, Nd: YAG, semiconductor), gas (He- Ne, CO2 and Excimer), liquid (organic dye) lasers.	08	2
3	Optical Resonators	Closed versus open cavities, modes of a symmetric confocal optical resonator, stability, quality factor.	08	3
4	Coherence and Pulsed Operation of Lasers	Concepts of coherence and correlation functions, coherent states of the electromagnetic field, minimum uncertainty states, unit degree of coherence, Poisson photon statistics. Q-switching, electro-optic and acousto-optic modulation, saturable absorbers, mode- locking	08	4
5	Applications of Lasers	Introduction to atom optics, Doppler cooling of atoms, introduction to nonlinear optics: self-(de) focusing, second-harmonic generation (phase-matching conditions).	08	5

Reference Books:

1. K. Thyagarajan and A.K. Ghatak, *Lasers: Theory and Applications*
2. A.K. Ghatak and K. Thyagarajan, *Optical Electronics.*
3. W. Demtroeder, *Laser Spectroscopy*
4. B.B. Laud, *Lasers and Non linear Optics*
5. M. Sargent III, M.O. Scully and W.E. Lamb, Jr., *Laser Physics*
6. M.O. Scully and M.S. Zubairy, *Quantum Optics.*
7. P. Meystre and M. Sargent III, *Elements of Quantum Optics*
8. L. Mandel and E. Wolf, *Optical Coherence and Quantum Optics.*

e-Learning Source:

1. https://nptel.ac.in/courses/104/104/104104085/
2. https://nptel.ac.in/courses/115/105/115105105/
3. https://nptel.ac.in/courses/115/105/115105104/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**3**	**1**	**1**	**1**		**2**	**1**						**3**	**3**	**2**	**2**	**3**	**3**
CO2	**3**	**1**			**3**	**1**							**2**	**1**	**1**	**1**	**3**	**3**
CO3	**3**	**1**	**3**		**1**	**1**							**2**	**1**	**1**	**1**	**3**	**3**
CO4	**3**	**1**	**1**		**2**	**1**							**3**	**3**	**2**	**2**	**3**	**3**
CO5	**3**	**1**	**3**		**2**	**2**	**1**						**3**	**3**	**2**	**2**	**3**	**3**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY514	**Title of the Course**	**Renewable Energy Resources**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	4th	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	❖ To understand the principle, origin conversion process, origin, advantages, disadvantages and limitation of Solar, Biomass, wind, Ocean, tidal, Geothermal Energy. ❖ To understand emerging trends of Renewable Energy sources (Fuel Cell, Hydrogen Cell and MHD Energy) ❖ To understand the analysis of Solar PV System, digester and windmill. ❖ To understand the concept of geothermal electric power plant.						

Course Outcomes	
CO1	Students will be able to explain renewable and renewable energy resources, solar cell, PV System and Photovoltaic concept. Also able to explain limitation and application of PV system.
CO2	Students will be able to explain biomass energy, biomass energy conversion process, fixed and continuous type digester and liquefaction and gasification process of biomass.
CO3	Students will be able to explain wind energy as a type of renewable energy, its origin and power in wind, principle of wind mill, Ocean energy and tidal energy.
CO4	Students will be able to explain geothermal energy and its resources, dry steam, wet steam & hot water geothermal system and geothermal power plant and thermal power plant.
CO5	Students will be able to answer the principle, operation classification, performance characteristic and types of fuel cell and also hydrogen as fuel, conversion to energy and Applications.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Solar Energy	Solar Energy conversion systems and their applications, Fundamentals of photovoltaic energy conversion, Principles of photo voltaic cell, Materials and fabrication technologies of P.V cell, P. V. Systems: configuration, output power and conversion efficiency, Basic P.V. system for power generation, Applications and limitations of P.V. systems.	08	1
2	Biomass Energy Conversion Technologies	Origin of biomass, Biomass energy resources, Biomass energy conversion processes, generation of gaseous fuels from biomass, digesters and their designs, Energy from Cereals, grains, sugar, fruits, starch etc.	08	2
3	Wind Energy & Ocean Energy	Introduction to wind energy, Nature & Origin of winds, Power in a wind stream, principles and basic components of wind mill, Efficiency of wind turbine, horizontal and vertical axis wind mills, performance of wind mills, merits and limitations of wind energy conversions. Ocean as the potential energy resource: various ocean energy conversion technologies, Introduction to OTEC, Principle of OTEC, Ocean waves, energy and power from ocean waves, origin of tidal energy, Tidal energy conversion, tidal energy conversion schemes.	08	3
4	Geothermal Energy	Geothermal energy as a renewable source of energy, Types of geothermal resources, Origin of geothermal resources, Hydro geothermal, Geopressure geothermal and Petro geothermal resources, Basics of geothermal electric power plant.	08	4
5	Emerging trends in Renewable Energy sources	Fuel Cells: Principle and operation of fuel cell, classification and types of fuel cells, Phosphoric acid fuel cell (PAFC), Alkaline fuel cell (AFC), Molton carbonate fuel cell (MCFC), Solid oxide fuel cell (SOFC), Fuels for fuel cells, Performance characteristics of fuel cells, Practical fuel cell power plant. Hydrogen Energy: Hydrogen as clean source of energy, sources Production, storage, Use of hydrogen as fuel, conversion to energy, Applications. Magneto hydrodynamics Energy: MHD generator, Basic principle,(H-12 M-20)	08	5

Reference Books:

Energy Technology Non-Conventional, Renewable and Conventional, S. Rao, Dr. B. B. Parulekar, Khanna Publications, 3rd Ed, 2005

Non-Conventional Energy Sources, G. D. Rai, Khanna Publications, 2000

Solar Energy Utilisation, G.D.Rai, Khanna Publishers (1996)

Non-Conventional Energy Resources, Khan B. H., Tata McGraw Hill. 2006

Solar Energy Conversion, S. P. Sukhatne(2nd editions)

Hydrogen as an Energy carrier Technologies systems Economy-Winter & Nitch

Solar Energy Conversion – A. E. Dixnon & J. D. Leslie.

e-Learning Source:

1. NPTEL :: General - NOC:Non-Conventional Energy Resources
2. NPTEL :: Electrical Engineering - Non-Conventional Energy Systems
3. https://archive.nptel.ac.in/courses/103/103/103103206/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO4	PSO5	PSO6
CO1	2	2	3	1	1	2	3						1	3	2			
CO2	3	1	2	1	1	3	1							2	2	3	1	
CO3	2	3	1			1	2								2		1	2
CO4	3	2	1	1		2	1						2	2	3	1		
CO5	1	3	2			1	2						3	1	2		1	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**