Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY301	**Title of the Course**	**Elements of Quantum Mechanics, Atomic and Molecular Spectra**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	To provide working knowledge of the Quantum Mechanics postulates on the physical systems and to introduce some of the basic systems in atomic physics. To gain greater familiarity with quantum mechanics by studying its application to atomic systems.						

Course Outcomes	
CO1	Would be able to analyze the inadequacies of classical mechanics in atomic domain and provide the understanding of quantum theory of light in order to analyze Blackbody Radiation.
CO2	Provided with the wavefunction of a system, students would be able to normalize it and determine the expectation values.
CO3	To solve the Schrodinger's equation for time independent problems like free particle, particle in an infinite potential well, square potential well, the step potential and potential barrier.
CO4	It includes an understanding of LS and JJ coupling in order to be able to use appropriate quantum numbers for labelling of energy levels.
CO5	To analyze the origin of electronic, vibrational and rotational energy levels and undertake simple calculations of energy levels.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Matter Waves	Inadequacies of classical mechanics, black body radiation, theoretical laws of black body radiation, photoelectric phenomenon, Compton effect, Planck's quantum hypothesis, development of quantum mechanics, Bohr's quantization condition, wave particle duality, de- Broglie hypothesis, velocity of de-Broglie waves, phase and group velocities and their relationship for a non-relativistic particle.	08	CO1
2	Schrodinger Equation I	Heisenberg's uncertainty principle with derivation and its applications, ground state energy of Hydrogen atom & linear harmonic oscillator Basic postulates of quantum mechanics, Schrodinger Equation: time dependent and time independent form, Physical interpretation of the wave function, orthogonality and normalization of wave functions, basic problem related to wave function, probability current density, Ehrenfest theorem.	08	CO2
3	Schrodinger Equation II	Applications of Schrodinger wave equation: (free particle, a particle in 1-D infinitely deep potential well, a particle in 3-D infinitely deep potential well, 1-D linear harmonic oscillator, one dimensional motion in step potential, rectangular potential barrier, square well potential), expectation values of dynamical quantities, momentum space wave function.	08	CO3
4	Atomic spectra	Spectra of hydrogen, deuteron and alkali atoms, spectral terms, doublet fine structure, screening constants for alkali spectra for s, p, d, and f states, selection rules, Singlet and triplet fine structure in alkaline earth spectra, L-S and J-J couplings. Weak spectra: continuous X-ray spectrum and its dependence on voltage, Duane and Haunt's law. Characteristics X-rays, Moseley's law, doublet structure and screening parameters in X-ray spectra, X-ray absorption spectra.	08	CO4
5	Molecular spectra	Discrete set of electronic energies of molecules, quantization of vibrational and rotational energies, determination of internuclear distance, pure rotation and rotation- vibration spectra, Dissociation limit for the ground and other electronic states, transition rules for pure vibration and electronic vibration spectra.	08	CO5

Reference Books:

1. A. Beiser, "Perspectives of Modern Physics (McGraw Hill).
2. H. E. White; "Introduction to Atomic Physics (D. Van Nostrand Company)
3. R. P. Feymann, R. B. Leighton and M. Sands; "The Feynman Lectures on Physics, Vol. III (B I Publications. Bombay. Delhi, Calcutta, Madras).
4. Eisenberg and Resnick; "Quantum Physics of Atoms, 'Molecules, Solids, Nuclei and Particles" (John Wiley).

e-Learning Source:

1. https://nptel.ac.in/courses/115/104/115104096/
2. https://nptel.ac.in/courses/115/102/115102023/
3. https://nptel.ac.in/courses/115/105/115105100/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2			1		1	3	1		
CO2	3	1			2		3	3	1		
CO3	3	1			2		3	3	1		
CO4	3	1			2		3	3	3	2	
CO5	3	1			2		3	3	3	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	PY302	**Title of the Course**	**Classical Mechanics, Relativity and Statistical Physics**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	To provide the dynamics of system of particles, motion of rigid body, Lagrangian and Hamiltonian formulation of mechanics and to give the students a thorough understanding of the theory and methods of statistical physics.						

Course Outcomes	
CO1	Students will gain an understanding of the Classical Mechanics and basic theories of Physics like Lagrangian and Hamiltonian Dynamics.
CO2	Students will be able to develop a deep understanding of various phenomena of Special Theory of Relativity and concept of mass-energy equivalence.
CO3	Students will be able to master basic statistical methods and concepts like probability, random variables, expected value, variance, estimators and common probability distributions.
CO4	Students will be able to write the distribution function of various systems and further calculate various thermodynamic potentials.
CO5	Interpretation of Maxwellian distribution. Analysis of statistical mechanical description of Fermi- and Bose- statistics for electron and photon.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Lagrangian and Hamiltonian Dynamics	Constraints: holonomic and non-holonomic, time independent and time dependent, Generalized coordinates, Lagrange equations from D'Alembert's principle, velocity dependent potentials, Variational principle: Technique of the calculus of variation, Hamilton's variational principle, Lagrange equations using Hamilton's principle, Generalized momenta, cyclic coordinates. Definition of Hamiltonian and its physical significance, Hamilton's equations of motion from variational principle.	08	CO1
2	Special Theory of Relativity	Reference systems, inertial frames, Galilean invariance and conservation laws, propagation of light, Michelson-Morley experiment; search for ether, Postulates for the special theory of relativity, Lorentz transformations, length contraction, time dilation, velocity addition theorem, variation of mass with velocity, mass-energy equivalence, particle with a zero rest mass.	08	CO2
3	The Statistical Basis of Thermodynamics	Probability and thermodynamic probability, principle of equal a priori probabilities, probability distribution and its narrowing with increase in number of particles.	08	CO3
4	Some Universal Laws	The μ (mu)- space representation, division of μ (mu)- space into energy sheets and into phase cells of arbitrary size, applications to one-dimensional harmonic oscillator and free particles, Equilibrium before two systems in thermal contact, Probability and entropy, Boltzmann entropy relation, Statistical interpretation of second law of thermodynamics.	08	CO4
5	Quantum Statistical Mechanics	**Maxwellian distribution of speeds in an ideal gas:** Distribution of speeds and of velocities, experimental verification, distinction between mean, r.m.s. and most probable speed values. **Transition to quantum statistics:** 'h' as a natural constant and' its implications, cases of particle in a one-dimensional box and one-dimensional harmonic oscillator, Indistinguishability of particles and its consequences, Bose-Einstein, and Fermi-Dirac distributions, photons in black body chamber, free electrons in a metal, Fermi level and Fermi energy.	08	CO5

Reference Books:

1. A. Beiser, "Concepts of Modern Physics" (McGraw-Hill).
2. B. B. Laud, "Introduction to Statistical Mechanics" (Macmillan 1981).
3. F. Reif, "Statistical Physics" (McGraw-Hill 1988).
4. K. Haung, "Statistical Physics" (Wiley Eastern, 1988).

e-Learning Source:

1. https://nptel.ac.in/courses/115/106/115106123/
2. https://nptel.ac.in/courses/115/105/115105098/
3. https://nptel.ac.in/courses/115/101/115101011/
4. https://nptel.ac.in/courses/104/101/104101125/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	1		1	2	3	1		
CO2	3	2	1	1		1	2	3	1		
CO3	3	1	1				1	3	1		
CO4	3	1				2	1	3	3	2	
CO5	3						2	3	3	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	PY303	**Title of the Course**	**Solid State, Nuclear and Particle Physics**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**2**	**1**	**0**	**3**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart basic and key knowledge of solid state, nuclear and particle physics. By using the principal of physics and mathematics to obtain quantitative relations which are very important for higher studies. After successfully completion of course, the students will be able to explore subject into their respective dimensions						

Course Outcomes	
CO1	Students will gain an understanding of crystal structure, diffraction and reciprocal lattice which help in determine the crystal structure of any material.
CO2	Students will gain an understanding of crystal bonding and the vibrations involved in crystal Lattice which help them to understand the concept of vibrational dynamics.
CO3	Students will gain an understanding of materials (metals and semiconductors) and able to find the band gap based on which they define the material type.
CO4	Students will understand the basic properties of nucleus, know about Nuclear Forces and Nuclear Reactions which helps in defining the type of nuclear reaction.
CO5	Students will gain basic knowledge of particle physics and ability to outline the physical origins of particle physics.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Crystal Structure	Lattice translation vectors and lattice, Symmetry operations, Basis and Crystal structure, Primitive Lattice cell, Two-dimensional lattice types, systems, Number of lattices, Number of Lattices, Index system for crystal planes, Miller indices, Simple crystal structures, NaCl, hcp, diamond. Bragg's law, experimental diffraction method, Laue method, rotating crystal method, powder method.	08	CO1
2	Crystal Bonding and Lattice Structure	Crystal of inert gases, Van der Walls-London interaction, repulsive interaction, Equilibrium lattice constants, Cohesive energy, compressibility and bulk modulus, ionic crystal, Madelung energy, evaluation of Madelung constant, Covalent crystals, Hydrogen-bonded crystals, Atomic radii. Lattice Heat capacity, Einstein model. Vibrations of monatomic lattice, derivation of dispersion relation, Force constants, Lattice with two atoms per primitive cell.	08	CO2
3	Band Theory	Hall effect (metals and semiconductors), Origin of band theory, Kronig-Penney model, Number of orbitals in a band, conductor, Semi- conductor and insulators, Effective mass, Concept of holes.	08	CO3
4	Nuclear Physics	**General Properties of Nucleus:** Brief survey of general Properties of the Nucleus, Mass defect and binding energy, charges, Size, Spin and Magnetic moment. **Nuclear Forces:** Saturation phenomena and Exchange forces, Deuteron ground state properties. **Nuclear Reactions:** Nuclear reactions and their conservation laws, Cross section of nuclear reactions, Theory of fission (Qualitative), Nuclear reactors and Nuclear fusion.	08	CO4
5	Particle Physics	Basic particle interactions (gravitational, Electromagnetic, week and strong interactions), Basic classification based on rest mass, Spin and half-life, particles and antiparticles, idea of resonances, conservation rules in fundamental interactions, determination of spin and parity of pions, strange particles.	08	CO5

Reference Books:

1. Puri and Babbar, "Solid State Physics" (S. Chand).
2. C. Kittel, "Introduction to Solid State Physics"- Vth Edition (John Wiley & Sons).
3. H. S. Mani and G. K. Mehta, "Introduction to Modern Physics" (Affiliated East-West Press—1989).
4. A. Beiser, "Perspectives of Modern Physics" (McGraw-Hill).
5. Martin, B.R. and Shaw, Particle Physics (John Wiley).

e-Learning Source:

1. https://nptel.ac.in/courses/115/104/115104109/
2. https://nptel.ac.in/courses/115/105/115105099/
3. https://nptel.ac.in/courses/115/103/115103101/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	1	1		2	1	1	3	1	2	2
CO2	3	1	2		3	1	1	3	1	2	
CO3	3	1	2		3	1	1	3	1	1	
CO4	3	1			2	1		3	3		2
CO5	3	1			2	1		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	PY304	**Title of the Course**	**Advance Electricity and Magnetism Lab**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**0**	**0**	**2**	**1**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in electricity and magnetism through different experiments.						

Course Outcomes	
CO1	To understand the concept of the charging and discharging of RC and LCR circuits and concept of Lissajous figures using a CRO
CO2	To understand the working and response of PV and Solar cell and determining the fill factor
CO3	To use ballistics galvanometer for various applications.
CO4	To understand the concept of decay of currents in LR and RC circuits and hence estimate the resonancefrequency and quality factor
CO5	Implement bridges for various applications.

Experiment No.	**Title of the Experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Charging and discharging of RC and LCR circuits	To study the charging and discharging of RC and LCR circuits.	2	CO1
2	Lissajous figures using a CRO	To study of Lissajous figures using a CRO.	2	CO1
3	Solar Cell	To study the spectral response of a solar cell.	2	CO2
4	Calibration of B.G.	To calibrate a ballistic galvanometer with a standard solenoid and then to find out ballistic constant.	2	CO3
5	Hall Probe Method	Hall Probe Method for measurement of magnetic Field.	2	CO3
6	Study of LR and RC circuits	Study of decay of currents in LR and RC circuits.	2	CO4
7	Frequency Response of LCR circuit	To study the response curve for LCR circuit and hence estimate the resonance frequency and quality factor.	2	CO4
8	Wien's Bridge	To determine the capacitance of a condenser by Wien's bridge.	2	CO5
9	Photo Cell	To draw the characteristic of a photoelectric cell.	2	CO2
10	Time Constant	To study Time constant in a LR circuit.	2	CO4

Reference Books:

1. Practical Physics. by R. K. Shukla, New Age International Private Limited; Third edition.
2. B.Sc. Practical Physics by Harnam Singh and Hemme, S. Chand.
3. B. Sc. Practical Physics by CL Arora, S Chand & Company.
4. Practical Physics by Kumar P.R.S., Prentice Hall India Learning Private Limited

e-Learning Source:

1. https://www.exploratorium.edu/snacks/subject/electricity-and-magnetism
2. https://ocw.mit.edu/courses/physics/8-02-physics-ii-electricity-and-magnetism-spring-2007/experiments/
3. http://www.rossnazirullah.com/BSc/BSc.htm

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1		3	1	2	1		1	3
CO2	2	1	3		2	2	3	2		1	3
CO3	3	2	2		3	3	2	3		2	3
CO4	2	3	3		1	2	3	3		3	3
CO5	3	2	1		3	1	2	2		1	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: 2018-19							
Course Code	**MT301**	**Title of the Course**	**Advanced Calculus**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Mathematics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart basic and key knowledge of differential & integral calculus. Students will be able to evaluate derivative of several functions using different techniques. They will also learn to evaluate different types of integrals. After successful completion of course, the student will be able to explore subject into their respective dimensions.						

Course Outcomes	
CO1	Students will gain an understanding of Function of several variables, Domains and Range, Functional notation, Limits and continuity and differentiability. They will also learn to find Partial derivatives, Differential of functions of n variables, Differentials of composite functions by using the chain rule.
CO2	Students will be able to understand Implicit functions, Inverse functions, They will also study directional derivatives and will be able to find Partial derivatives of higher order, Higher derivatives of composite functions. They will learn to find Maxima and minima of functions of several variables.
CO3	Students will gain an understanding of Line integrals in the plane, Basic properties of Line integrals, Line integrals as integrals of vectors and will be able to solve line integral by Green's theorem , and get knowledge of independence of path, simply connected domains , Extension of result of multiply connected domains.
CO4	Students will create the own understanding and find Double integral over a rectangular region, Double integral as volume, Area of a region in a plane., Transformation of double integral from Cartesian to polar co - ordinate and vice versa. They will study triple integral and learn to solve them in Cartesian , cylindrical and spherical co – ordinate.
CO5	Students will gain an understanding of solution of Improper integrals, convergence of Camparison test, convergence of Abel's test, Dirichlet's test, convergence of. They will also study convergence of beta and gamma functions.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Function of several variables, Domains and Range, Functional notation, Limits and continuity and differentiability, Partial derivatives, Differential of functions of n variables, Differentials of composite functions, chain rule.	8	1
2		Implicit functions, Inverse functions, The directional derivatives, Partial derivatives of higher order, Higher derivatives of composite functions, Maxima and minima of functions of several variables.	8	2
3		Line integrals in the plane, Basic properties of Line integrals, Line integrals as integrals of vectors, Green's theorem , independence of path, simply connected domains , Extension of result of multiply connected domains.	8	3
4		Double integral over a rectangle region, Double integral as volume, Area of a region in a plane , Transformation of double integral from Cartesian to polar co - ordinate and vice versa, Triple integral in Cartesian , cylindrical and spherical co - ordinate .	8	4
5		Improper integrals, convergence of $\int_a^\infty f(x)dx$, Comparison test, convergence of $\int_a^\infty \frac{dx}{x^n}dx,\ a>0$, Abel's test, Dirichlet's test, convergence of $\int_a^\infty \frac{dx}{(x-a)^n}dx,\ a>0$, convergence of beta and gamma functions.	8	5

Reference Books:

1. G. B. Thomas, M.D. Wier, J. Hass: Calculus, Pearsons Education
2. S. C . Malik and S. Arora : Mathematical analysis, Wiley Eastern Ltd
3. D. V. Widder: Advanced Calculus, Prentice Hall of India Pvt. Ltd.

e-Learning Source:

1. https://nptel.ac.in/courses/111107108/
2. file:///C:/Users/Admin/Downloads/Vector%20Calculus%20by%20Krishna%20Series.pdf
3. https://www.academia.edu/8509213/Advanced_Calculus._Fifth_Edition-Wifred_Kaplan

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	2	1	1	1	2	2	2	3	2	3
CO2	3	2	2	1	1	1	2	1	1	2	2	2
CO3	3	2	2	1	1	1	2	2	2	2	2	2
CO4	3	1	2	1	1	1	2	2	2	3	3	2
CO5	3	1	2	1	1	1	2	3	2	2	3	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: 2018-19							
Course Code	**MT302**	**Title of the Course**	**Mathematical Statistics**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	The course explores the basic concepts of modern statistics and its applications for decision-making in economics, business, and other fields of sciences. Our everyday lives, as well as economic and business activities, are full of data analysis and distribution theory offer useful techniques for quantifying these uncertainties. The course is heavily oriented towards the formulation of mathematical statistics and practical applications.						

Course Outcomes	
CO1	To understand the definition and scope of Statistics, concepts of statistical population and sample. Quantitative and qualitative data, primary and secondary sources of data collection, scales of measurement- nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical form including bar diagram, histogram, pie chart, frequency curve and frequency polygon
CO2	Able to solve Measures of Central Tendency: Arithmetic mean, median, mode, geometric mean and harmonic mean, quartiles and percentiles. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation and variance, coefficient of variation and coefficient of skewness
CO3	To understand Bivariate data: Definition, scatter diagram, Karl Pearson's coefficient of correlation Spearman coefficient rank correlation and tied ranks. Simple linear regression, principle of least squares
CO4	To understand Definitions of Probability – classical, statistical, and axiomatic, random experiments, sample space and events, laws of addition and multiplication, independent events, conditional Probability and Bayes' theorem
CO5	To understand Mathematical expectation, Probability mass function (pmf) and Probability density function (pdf). Binomial Probability distributions, Poisson Probability distributions, and Normal Probability distributions.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		The definition and scope of Statistics, concepts of statistical population and sample. Quantitative and qualitative data, primary and secondary sources of data collection, scales of measurement- nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical form including bar diagram, histogram, pie chart	8	1
2		Measures of Central Tendency: Arithmetic mean, median, mode, geometric mean and harmonic mean, quartiles and percentiles. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation and variance, coefficient of variation and coefficient of skewness	8	2
3		Bivariate data: Definition, scatter diagram, Karl Pearson's coefficient of correlation Spearman coefficient rank correlation and tied ranks. Simple linear regression, principle of least squares	8	3
4		Definitions of Probability – classical, statistical, and axiomatic, random experiments, sample space and events, laws of addition and multiplication, independent events, conditional Probability and Bayes' theorem	8	4
5		Mathematical expectation, Probability mass function (pmf) and Probability density function (pdf). Binomial Probability distributions, Poisson Probability distributions, and Normal Probability distributions	8	5

Reference Books:

1. Sampling techniques: W.G. Cochran, Wiley
2. Sampling methodologies and applications: P.S.R.S. Rao, Chapman and Hall/CRC 2000
3. Elements of sampling theory and methods: Z. Govindrajalu, Prentice Hall, 1999
4. Sampling: P. Mukhopadhyaya, Prentice Hall of India, 1998
5. Theory of sample surveys with applications: P.V.Sukhatme, B.V.Sukhatme, S. Sukhatme and C. Asok, IASRI, Delhi, 1984.
6. Sampling Techniques: Daroga Singh & Chaudhry, F.S New age International

e-Learning Source:

1. https://www.youtube.com/watch?v=be9e-Q-jC-0
2. https://www.youtube.com/watch?v=bQ5_PPRPjG4
3. https://www.youtube.com/watch?v=jauhoR7w1YM

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	2	2	2	1	1	2	2	2
CO2	3	3	2	2	2	3	2	2	2	2	3	3
CO3	2	2	3	3	2	2	2	2	2	2	3	3
CO4	2	2	2	3	2	2	1	1	2	2	2	3
CO5	2	3	2	3	2	2	3	2	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: 2018-19							
Course Code	**MT303**	**Title of the Course**	**Number Theory**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**2**	**1**	**0**	**3**
Pre-Requisite	10+2 with PCM	**Co-requisite**					
Course Objectives	The course is intended to allow students to be exposed to some foundational ideas in number theory without the technical baggage often associated with a more advanced courses. The course provides students an opportunity to develop an appreciation of pure mathematics while engaged in the study of number theoretic results. The course is also designed to provide students an opportunity to work with conjectures, proofs, and analysing mathematics.						

Course Outcomes	
CO1	Can be able to demonstrate Cartesian product of sets, Equivalence relation and partition, Fundamental theorem of equivalence of relation, Equivalence sets.
CO2	Demonstrate knowledge and understanding of topics including, but not limited to divisibility, cardinal numbers, congruence's, quadratic reciprocity, Diophantine equations and cantor's theorem.
CO3	Can analyse hypotheses and conclusions of mathematical statements of divisibility, congruence, greatest common divisor, prime, and prime factorization.
CO4	Can apply different techniques of congruence to verify mathematical assertions, including proof by induction, by contrapositive and by contradiction tie and by contradiction.
CO5	Can solve systems of Diophantine equations using the Chinese Remainder Theorem & the Euclidean algorithm and Lagrange's theorem.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Cartesian product of sets, Equivalence relation and partition, Fundamental theorem of equivalence of relation, Equivalence sets.	6	1
2		Cardinal numbers, power of continuum, cardinal arithmetic, Inequalities in cardinals, Cantor's theorem, Schrodar Berntien Theorem	6	2
3		Division Algorithm, greatest common divisor, least common multiplier, prime number, unique factorisation theorem.	6	3
4		Congruence, Complete residue theorem, Euler's theorem	6	4
5		Linear congruence, Chinese remainder theorem, problem based on Chinese remainder theorem, Lagrange's theorem	6	5

Reference Books:

1. J Hunter: Number Theory
2. David M. Burton: Elementary Number Theory
3. Seymour Lipschutz: Set theory and related topics

e-Learning Source:

1. https://www.youtube.com/watch?v=SCvtxjpVQms
2. https://www.youtube.com/watch?v=-Qtl4nn7R4A

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	1	2	3	3	2	2	3	2	3
CO2	3	2	1	1	2	1	3	1	1	3	2	2
CO3	2	2	1	1	2	1	3	2	2	2	1	2
CO4	3	2	2	1	1	1	1	2	2	2	3	3
CO5	3	2	1	1	2	1	3	3	2	2	3	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: 2018-19							
Course Code	**MT304**	**Title of the Course**	**Statistical Techniques Lab**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	To make students capable of describing data in practical situations simultaneously to teach students to make proper and efficient use of the tools which are used to describe data. To make students able to fit real time data on various pre-defined probability distributions.						

Course Outcomes	
CO1	After completing Practical 1, students will be able to create visual representation of various types of data.
CO2	After the completion of Practical 2, 3 and 4, students will be able to well describe the central value and variability of data. Students will also learn the method of comparison of variability between to or more data sets and to figure out the shape of the given data in terms of skewness and Kurtosis.
CO3	After the completion of Practical 5, 6 & 7 students will be able to obtain the degree of relationship between two or more variables for qualitative and quantitative data both. Students will also be able to find out functional relationship between two or more variables.
CO4	After the successful completion of Practical 8, students will be able to fit real data on a given Binomial distribution.
CO5	After the successful completion of Practical 9 & 10, students will be able to fit real data on a given Poisson & Normal distribution.

Experiment No.	**Title of the Experiment**	**Content of the Unit**	**Contact Hrs.**	**Mapped CO**
Practical 1		Graphical representation (bar, histogram and pie chart) of data.	4	1
Practical 2		Problems based on measures of central tendency (Mean, median and mode).	4	2
Practical 3		Problems based on measures of dispersion (MD, SD and CV)	4	2
Practical 4		Problems based coefficient of skewness.	4	2
Practical 5		Karl Pearson correlation coefficient.	4	3
Practical 6		Lines of regression, angle between lines and estimated values of variables.	4	3
Practical 7		Problems based on Spearman rank correlation with and without ties.	4	3
Practical 8		Fitting of binomial distributions for n and p given	4	4
Practical 9		Fitting of Poisson distributions for given value of lambda	4	5
Practical 10		Fitting of Normal distribution for given value of mean and variance	4	5

Reference Books:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

e-Learning Source:

1. https://youtu.be/KIBZUk39ncI
2. https://www.youtube.com/watch?v=m9a6rg0tNSM
3. https://www.youtube.com/watch?v=nqPS29IvnHk
4. https://www.youtube.com/watch?v=JPK0LFsu18g
5. https://www.youtube.com/watch?v=vvv9DhUrzlY
6. https://www.youtube.com/watch?v=uq5w2aFwNhE&list=PLLgJVrtHe9RoB9LlZPuwv_zZNmGniGrai
7. https://www.youtube.com/watch?v=5lh1Wr5_1Q0&list=PLGihLBEp_66K6zl4QGMXIf-d1hcoXIQ0a

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	2	1	1	1	3	2	2	1	2	3
CO2	3	1	2	1	2	1	3	3	3	2	2	1
CO3	3	2	1	1	2	1	2	2	2	2	3	3
CO4	2	1	1	1	2	1	3	2	2	3	3	2
CO5	2	2	1	2	2	1	3	2	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	**EC321**	**Title of the Course**	**Network Circuit Analysis**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	**Fifth**	3	1	0	4
Pre-Requisite	10+2 with Physics and Mathematics	**Co-requisite**	Basic understanding of different types of electrical circuits, Kirchhoff's Voltage Law (KVL) and Current Law (KCL)				
Course Objectives	• To understand and analysis of Network equations like,, Source transformation, Loop variable analysis, Node variable analysis, Network theorem: Superposition, Thevenin's, Norton's & Maximum power transfer theorem, Millman's theorem . • To understand the concepts of various types of Transient analysis of different electrical circuits with and without initial conditions using Laplace Transform. • To understand the concept of poles and zeros, Stability and Positive real function • To understand the concept of Network Synthesis of RC, LC and Networks using Cauer's and Foster's first and second form . • To understand and analysis of different types of Two-port networks and analysis using network parameters with different types of connections. • To understand the concept of graph theory for the graphical solution of electrical circuits						

Course Outcomes	
CO1	Students will be able to apply the KVL ,KCL and Network Theorems for finding the solutions of network problems
CO2	Students will be able to formulate and analyze the Transient analysis of different electrical circuits with and without initial conditions using Laplace Transform.
CO3	Students will be able to check the stability and able to Synthesis the Network using Cauer's and Foster's first and second form .
CO4	Students will be able to solve and analyze the two port networks.
CO5	Students will be able to analyse a circuit using graph theory

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Network Theorems	Kirchoff's law, Source transformation, loops variable analysis, node variable analysis and duality. AC Network theorems: Superposition, Thevenin's, Norton's, Millman, Telegen's and maximum power transfer theorems.	8	1
2	Transient and steady state analysis	Transient and steady state analysis for R-L, R-C, RLC circuits, Use of Laplace transform, Initial value and final theorem, Solution of differential equations using laplace transform , waveform synthesis.	8	2
3	Concept of stability	Concept of poles and zeros, Stability, Frequency response Positive real function: Definitions and properties, Synthesis of RC, LC and Networks using Cauer's and Foster's first and second form.	8	3
4	Two port networks	Two port networks, two port parameters, Inter-Conversion of two port Parameters, Network Functions: Driving point and transfer function Interconnections of Two port networks, Symmetry, Ladder Networks, Characteristic impedance-pie transformation.	8	4
5	graph theory	Introduction to graph theory, Definitions, Graphs, Three, Walk, Path, Loop, Co- tree, Cut-set matrices for planer network, loop and nodal analysis.	8	5

Reference Books:

1. J. A. Edminister, Electric Circuits, Schaum Series, PHI.
2. W.H. Hayt and Jack. E. Kammerly, Engineering Circuit Analysis, Tata Mc Graw Hill
3. A.Hussain, Network and Systems, Khanna publications.

e-Learning Source:

1. NPTEL :: Electrical engineering- NOC: Networks and Systems

	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	1				
CO2	**3**	**1**					**2**						1	1				
CO3	**3**	**1**					**2**						2	1				
CO4	**3**	**1**					**2**						1	1				
CO5	**3**	**1**					**2**						1	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	EC322	**Title of the Course**	Consumer Electronics	**L**	**T**	**P**	**C**
Year	**Second**	**Semester**	Third	**3**	**1**	**0**	**4**
Pre-Requisite	10 +2 with Physics and Mathematics	**Co-requisite**	Understanding of basic consumer devices				
Course Objectives	1. This subject deals with the fundamentals of electronics and the operation of commonly used components in consumer electronic devices. 2. To provide fundamental knowledge about the various gadgets of consumer electronics. 3. To provide fundamental knowledge about the basics of electronics, operations of audio and video systems , office and home appliances. 4. The knowledge of systematic approach to the choice of different electronic gadget.						

Course Outcomes	
CO1	To familiarize with the Microphones, Loudspeakers, Speaker baffle, Electronic tuning, Amplifying Systems, Equalizers and Mixers, Hi-Fi systems, Electronic Music Synthesizers
CO2	To familiarize with theTV systems, LED display, HDTV, UHDTV, Video Conferencing, CCTV systems
CO3	To familiarize with the Recording and Reproduction Systems: Hard Disk, Optical disks (CD/DVD), Blue Ray disk, USB, Dolby noise reduction, digital and analog recording
CO4	To familiarize with the Appliances and Systems: Electronics toys, calculators, Washing machines, Microwave ovens, Air- conditioners and Refrigerators, FAX, Xerox, EPABX, Cellular Mobile,Walky-Talky.
CO5	To familiarize with the Power Supplies and other systems: SMPS, UPS and Preventive Maintenance, Set Top Boxes, Remote controls, Barcodes, ATM, Bluetooth.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Audio Systems	Microphones, Loudspeakers, Speaker baffle, Electronic tuning, Amplifying Systems, Equalizers and Mixers, Hi-Fi systems, Electronic Music Synthesizers	8	CO1
2	Video Systems and Displays	TV systems, LED display, HDTV, UHDTV, Video Conferencing, CCTV systems.	8	CO2
3	Recording and Reproduction Systems	Hard Disk, Optical disks (CD/DVD), Blue Ray disk, USB, Dolby noise reduction, digital and analog recording .	8	CO3
4	Appliances and Systems	Electronics toys, calculators, Washing machines, Microwave ovens, Air- conditioners and Refrigerators, FAX, Xerox, EPABX, Cellular Mobile,Walky-Talky.	8	CO4
5	Power Supplies and other systems	SMPS, UPS and Preventive Maintenance, Set Top Boxes, Remote controls, Barcodes, ATM, Bluetooth.	8	CO5

Reference Books:

1. J. F. Kennedy, "Electronic communication System"; TMH
2. Dhake, "Modern Television &Video Engineering"; TMH
3. Andris Krupin, Juris Medved, Rahul Khanna "Handbook of Electronics & Telecommunication", Scitus Academics LLC, 2016

e-Learning Source:

1. https://archive.nptel.ac.in/courses/117/104/117104022/
2. https://archive.nptel.ac.in/courses/117/106/117106091/

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	PSO7
CO1	3	3	2	3		1	1		2	1		2	3				1	3	
CO2	3	3	3	3		1			1	1		2	3	2			1	3	2
CO3	3	3	2	3		1			1			1	3					3	
CO4	3	3	2	2			1		2	1			3	1				3	1
CO5	3	3	3	3					1			2	3				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	**EC323**	**Title of the Course**	**Microprocessor and Microcontroller**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	**Fifth**	**3**	**1**	**0**	**4**
Pre-Requisite	Computer Architecture, Digital Electronics	**Co-requisite**					
Course Objectives	• The purpose of this course is to to introduce students with the architecture and operation of typical microprocessors and microcontrollers, understand the conceptof memory organization, different types of mapping. • To learn the instruction set of 8085, programming techniques. To understand the basic concepts of interrupts. • To learn the different data transfer schemes, functions of different peripherals and learn the interfacing of Ics with the microprocessor. • To understand the concept of internal architecture and organization of 8086, design and develop assembly language programs. • To understand the concepts of embedded system. To learn the Pin diagram, Architecture, Addressing mode, Instruction set of Microcontroller 8051.						

Course Outcomes	
CO1	Students shall be able to understand the microprocessor's internal architecture and its operation, describe the memory organization, types of mapping, also analyze the design aspects of I/O and memory interfacing circuits.
CO2	Students shall be able to understand the instruction set, also able to evaluate basic binary math operations using the microprocessor and able to design and develop simple assembly language programs using 8085 microprocessor.
CO3	Students shall be able to describe the functions of different peripherals and able to apply the concepts of interfacing microprocessors with peripheral devices (8255, 8259 etc).
CO4	Students shall be able to understand the internal architecture and organization of 8086, design and develop assembly language programs and will be able to compare and select the appropriate Microprocessor (8085 & 8086)according to the applications..
CO5	Students shall be able to analyze and compare the features of microprocessors and Microcontrollers also they will be able to plan small circuits for various applications using microcontrollers.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Evolution of Microprocessors, Comparison of RISC & CISC, Introduction to 8085: Microprocessors initiated operations & bus organisation, internal data operations, 8085 registers, externally initiated operation, memory organization, mapping & types- types of I/O addressing, memory mapped I/O, functional block, pin diagram, instructions & timing, instruction classification.	8	1
2		Programing & Architecture, instruction set of 8085, programming technique, stack & subroutine, Interrupt and its type, simple illustrative programs.	8	2
3		Data transfer schemes, Introduction to programmable peripheral devices (8255A, 8257, PIC 8259, USART 8251) and interfacing of PPI 8255 with 8085 processor.	8	3
4		Introduction to 8086, architecture, addressing modes, Pin diagram & it's Min./Max. configuration. Introduction to Advance processors (386, 486 & Pentium processors) Introduction– MMX technology.	8	4
5		Comparison between Microprocessor, Microcontroller & embedded system, 8051 Microcontroller: Pin diagram, Architecture, Addressing mode, Instruction set, Applications of Microcontrollers. Internal and External memories of embedded system	8	5

Reference Books:

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 4th Edition, Penram International Publishing, New Delhi, 2000.
2. Kennith J Ayala, 8051 Microcontroller, Thomson, 2005.
3. Dougles V Hall, Microprocessor and Interfacing, Tata MC Graw Hill Publication, 2nd Edition, 1992.
4. Charless M Gilmore, "Microprocessor Principle and application, McGraw Hill publication, 1995.

e-Learning Source:

1. https://nptel.ac.in/courses/108/105/108105102/
2. http://www.digimat.in/nptel/courses/video/108105102/L60.html
3. https://nptel.ac.in/courses/108/107/108107029

	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**
CO1	3	1	3		2	2	1						3	2	1	
CO2	3	2	3		2		1						3	3	1	1
CO3	3	3	3	2	1	2							3	2	1	
CO4	3	3	2		2	2							3	3		1
CO5	3	2	2	1	1								3	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	**EC324**	**Title of the Course**	**Microprocessor and Microcontroller Lab**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	**Fifth**	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	The main objective of this lab course is to gain the practical hands-on experience of programming the 8086 microprocessor and 8051 microcontroller and also to gain knowledge on interfacing of different peripherals to microprocessor. Microprocessor technology is an exciting, challenging and growing field which will pervade industry for decades to come. To meet the challenges of this growing technology, one has also to be conversant with the programming aspects of the microprocessor and microcontroller.						

Course Outcomes	
CO1	Ability to understand microprocessor basics.
CO2	Ability to understand and analyse different microprocessor and microcontroller architectures.
CO3	Ability to familiarize Instruction sets.
CO4	Ability to develop Programming skills.
CO5	Ability to understand different Simulation Environments

Experiment No.	Title of the Experiment	Content of Unit	Contact Hrs.	Mapped CO
1	Addition of 16 bit hexadecimal number without carry	Write an assembly language program to add two 16 bit hexadecimal number without carry	4	CO1
2	Addition of 16 bit hexadecimal number with carry	Write an assembly language program to add two 16 bit hexadecimal number with carry	4	CO1
3	Multiplication of 16 bit hexadecimal number	Write an assembly language program to multiply two 16 bit hexadecimal numbers.	4	CO2
4	Subtraction of Multibyte numbers	Write an assembly language program to subtract two Multibyte numbers.	4	CO2
5	Movement of a block of data without overlap	Write an assembly language program to move a block of data without overlap.	4	CO3
6	Conversion of 16 bit hexadecimal number to decimal number	Write an assembly language program to convert a 16 bit hexadecimal number to decimal number.	4	CO3
7	Largest number from the given array	Write an assembly language program to find largest no from the given array	4	CO4
8	Square of a number	Write an assembly language program to find the square of a number	4	CO4
9	Bubble Sort in ascending number	Write an assembly language program to sort a given set of 16 bit unsigned integers into ascending order using bubble sort algorithm.	4	CO5
10	Bubble Sort in descending number	Write an assembly language program to sort a given set of 16 bit unsigned integers into descending order using bubble sort algorithm.	4	CO5

Reference Books:

1. Ramesh S Goankar, “Micropocessor Architecture: Programming and Applications with the 8085”, Penram International, Fifth Edition, 2002.
2. Jochen Steve Furber, “ARM System-on-Chip Architecture”, Addison Wesley Trade Computer Publications, Second Edition, 2000.

e-Learning Source:

1. NPTEL Course : Microprocessors And Microcontrollers (https://onlinecourses.nptel.ac.in/noc20_ee42/preview)

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1		3	1	1	1		1	3
CO2	3	1	1		2	2	3	2		1	3
CO3	3	2	2		3	3	2	3		2	3
CO4	3	2	1		1	2	3	3		3	3
CO5	3	2	1		3	1	2	2		1	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	PY305	**Title of the Course**	**Applied Electronics**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart basic and key knowledge of electronics and its applications. By using the principles of modern physics and mathematics to obtain quantitative relations which are very important for higher studies. After successfully completion of course, the students will be able to explore subject into their respective dimensions.						

Course Outcomes	
CO1	Students will gain an understanding of modern physics and characterization of semiconductor based electronic devices.
CO2	Students will be able to realize the important concepts of advance electronics related to bipolar junction transistors.
CO3	Students will gain an understanding of advanced concepts of transistors and related to biasing circuits for small- and large-scale signal conditioning, power amplifications and effect of external factors in transistor operations.
CO4	Students will learn about the high switching semiconducting devices like FETs and MOSFETs for designing power supplies for industrial and commercial applications.
CO5	Students will learn about the Power electronic devices like the UJT, TRIAC, etc. and designing Integrated Circuits for fabrication of high yield monolithic ICs.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Semiconductor and p-n junction diode	Diffusion of minority carriers in semiconductor, work function in metals and semiconductors Junctions between metal and semiconductors, Semiconductor and p.n. Junction, Depletion layer, Junction Potential Width of depletion layer, Field and Capacitance of depletion layer, Forward A.C. and D.C. resistance of junction, Reverse Breakdown, Zener and Avalanche diodes, Tunnel diodes, Point contact diode, their importance at High frequencies, LED photodiodes, Effect of temperature on Junction diode Thermistors.	08	CO1
2	Transistor-I	Transistor parameters, base width modulation, transit time and life-time of minority carriers, Base-Emitter resistance Collector conductance, Base spreading resistance, Diffusion capacitance, Reverse feedback ratio, Equivalent circuit for transistors, Basic model, hybrid model and Y parameter equivalent circuit, Input and output impedances.	08	CO2
3	Transistor-II	Current and Voltage gain, Biasing formulae for transistors, Base bias, emitter bias and mixed type bias and mixed type biasing for small and large signal operation, Transistor circuit application at law frequencies, their AC and DC equivalent for three different modes of operation, Large signal operation of transistors, Transistor Power amplifiers, Class A and B operation, Maximum power output Effect of temperature, heat sinks, thermal resistance Distortion in amplifiers, cascading of stages, Frequency response, Negative and positive feedback in transistor amplifiers.	08	CO3
4	Field effect transistors and Power Supplies	Field effect transistors and their characteristics, biasing of FET, use in preamplifiers, MOSFET and their simple uses. Electronically regulated low and high voltage power supplies, Inverters for battery operated equipments. Phototransistors, Silicon Controlled rectifiers.	08	CO4
5	Power Electronics and Integrated Circuits	Triac Construction, Operation and Characteristics, Unijunction Transistors (UJT), its characteristics, IC-classification, Making monolithic ICs, IC-fabrication of components on monolithic IC, IC packings, IC symbols.	08	CO5

Reference Books:

1. B. G. Streetman; "Solid State Electronic Devices", UK Edition (Prentice-Hall of India. New Delhi, 1986).
2. W. D. Stanley; "Electronic Devices, Circuits and Applications" (Prentice-Hall, New Jersey, USA. 1988).
3. J. D. Ryder; "Electronics Fundamentals and Applications" IInd Edition (Prentice-Hall of India. New Delhi, 1986).
4. I. Millman and A. Grabel; "Microelectronics", International. Edition (McGraw-Hill Book Company, New York, 1988).

e-Learning Source:

1. https://nptel.ac.in/courses/117/107/117107095/
2. https://nptel.ac.in/courses/108/101/108101091/
3. https://nptel.ac.in/courses/117/103/117103063/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	2	1	2	3	2	1	2	2
CO2	1	3	2		3	1	2	1	2	3	3
CO3	3	2	1	1	2	2	3	3	3	2	2
CO4	2	2	3		1	1	2	1	2	2	3
CO5	1	3	1	2	3	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	PY306	**Title of the Course**	**Physics of Materials**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart basic and key knowledge of materials. By using the basic knowledge of materials to obtain quantitative relations which are very important for further research. After successfully completion of course, the student will be able to explore subject into their respective dimensions.						

Course Outcomes	
CO1	To learn about crystal structure and its fractures
CO2	To introduce crystal imperfection and elastic properties of crystals.
CO3	To introduce the structure of metals, alloys, ceramics and glasses and their processing.
CO4	To Introduce the Nanomaterials and nanotechnology
CO5	To learn various characterization techniques of nanoparticles or nanomaterials

Experiment No.	Title of the Experiment	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction	**Introduction:** Atomic basis of structure – ionic bonding, Covalent bonding, Metallic bonding, Secondary bonding, Crystalline and non-crystalline states, crystal symmetry, silica and silicates, polymers, fullerenes. **Fracture:** Ductile fracture, Brittle fracture, Fracture toughness, Ductile-brittle transition, Protection against fracture, Fatigue fracture.	08	CO1
2	Crystal Imperfections and Elastic Properties	**Crystal Imperfections:** Point, line, surface and volume imperfections, dislocations and their geometry, Disorder in polymers and non-crystalline materials. **Elastic Properties:** Elastic behavior and its atomic model, Rubber like elasticity, anelastic behavior, relaxation processes, viscoelastic behavior, plastic deformation	08	CO2
3	Structure and Processing of Materials	Structure of metals and alloys, structure of ceramics and glasses, structure of polymers, structure of composites (qualitative). Brief introduction of processing of metals, alloys, ceramic and glasses.	08	CO3
4	Introduction to Nanomaterials	Brief introduction of nanomaterials, properties of Nanomaterials. Methods to produce nanomaterials: Sol-Gel synthesis method. Applications of nanomaterials. Carbon Nanomaterials: classification and properties, Nanowires: classification, properties and applications. Nanocomputers.	08	CO4
5	Tools and Techniques	Crystallography: Particle size determination, Electron Microscopy: Scanning Electron Microscopy (SEM), Tunneling Electron Microscopy (TEM) (qualitative), sample preparation for an electron microscope, Difference between TEM and SEM, Disadvantages of electron microscope, atomic force microscope (AFM) (qualitative).	08	CO5

Reference Books:

1. Introduction to Solid State Physics: C. Kittel (Wiley, VII ed.)
2. Introduction to Solids: L.V. Azaroff (Tata McGraw Hill).
3. Solid State Physics: A.J. Dekker (Prentice-Hall).
4. Essentials of Materials Science: A.G. Guy (McGraw Hill).

e-Learning Source:

1. https://nptel.ac.in/courses/115/104/115104109/
2. https://nptel.ac.in/courses/115/105/115105099/
3. https://nptel.ac.in/courses/113/107/113107075/
4. https://nptel.ac.in/courses/115/101/115101007/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	2	1	2	3	2	1	2	2
CO2	1	3	2		3	1	2	1	2	3	3
CO3	3	2	1	1	2	2	3	3	3	2	2
CO4	2	2	3		1	1	2	1	2	2	3
CO5	1	3	1	2	3	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	PY307	**Title of the Course**	**Mathematical Methods in Physics (Elective 1)**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving advanced problems in theoretical physics.						

Course Outcomes	
CO1	Students will be able to apply the methods of vector analysis. These methods provide a natural aid to the understanding of geometry and some physical concepts. They are also a fundamental tool in many theories of Applied Physics.
CO2	Students will be able to use computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, eigenvalues and eigenvectors, orthogonality, and diagonalization. (Computational and Algebraic Skills).
CO3	Students will understand the convergence and divergence of infinite series and to evaluate successive differentiation and determine the area and volume by applying the techniques of double and triple integrals.
CO4	Students will express the concept of probability and its features, explain the concept of a random variable and the probability distributions.
CO5	Students will use the gamma function, beta function and special functions to: evaluate different types of integral calculus problems and Fourier series to solve differential equations.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Vector Calculus and Curvilinear Coordinates	Vector Calculus and Curvilinear Coordinates Differential vector operators: Gradient, divergence and curl. Gauss's theorem, Green's theorem, Stoke's theorem, Some simple examples based on these theorems, orthogonal curvilinear coordinates, cylindrical and spherical polar coordinates, divergence, gradient, curl and Laplacian in these coordinates.	08	CO1
2	Vector Spaces and Linear Algebra	Determinants for linear algebraic equations, Laplace development, Cramer's rule, antisymmetry, Gauss elimination. Matrices–basic definition, classification and operations, orthogonal matrices, Hermitian matrices, unitary matrices, Rank of matrices, eigenvalues and eigenvectors.	08	CO2
3	Infinite Series and Multiple Integrals	Infinite Series: Fundamental concepts, convergence tests, alternating series, algebra of series, power series, Taylor series. Multiple Integrals: Double and triple integrals, application of multiple integrals, change of variables in integrals, general properties of Jacobians, surface and volume integrals.	08	CO3
4	Statistics and Probability	Statistics and Probability: Statistical distributions, second moments and standard deviations, definition of probability, fundamental laws of probability, discrete probability distributions, combinations and permutations, continuous distributions: expectation, moments and standard deviation, Binomial, Poisson and Gaussian distributions.	08	CO4
5	Special Functions	Beta and gamma functions: problems, relation between beta and gamma functions, Bessel's differential equations, Legendre's differential equations, Hermite's differential equations, Laguerre's differential equations (Qualitative), series solutions, Dirac delta functions and its properties.	08	CO5

Reference Books:

1. Mathematical Methods for Physicists: G. Arfken and H. J. Weber (Academic Press, San Diego) 7th edition, 2012.
2. Mathematical Methods in the Physical Sciences, M.L. Boas (Wiley) 2002.
3. Applied Mathematics for Engineers and Physicists, L. A. Pipes & L. R. Harvill (McGraw- Hill), 1971.
4. Mathematical Methods for Physics and Engineering, K. F. Riley, M.P. Hobson and S.J. Bence (Cambridge University Press), 1998.

e-Learning Source:

1. https://www.freebookcentre.net/Physics/Mathematical-Physics-Books.html
2. https://nptel.ac.in/courses/115106086/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	1	1		2	1	2	3	2	1	1
CO2	3	1	2	1	3		3	2	3	3	1
CO3	2	3	2		3	2	2	3	1	2	2
CO4	3		1	1	2		1	2	2	3	1
CO5	1	2	1	2	2	1		3	2	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	PY308	**Title of the Course**	**Advanced Solid-State Physics (Elective 2)**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	This course aims to extend the material covered in the basic courses in Solid State Physics, Electronic Materials and Device Physics and provide a broader and deeper understanding of the physics of today's semiconductor devices. This includes discussions on the materials properties and optical properties underlying fundamental devices.						

Course Outcomes	
CO1	Students will gain an understanding of the vibrations involved in Lattice which help them to understand the concept of phonon and vibrational dynamics.
CO2	Students will gain knowledge of semiconductor and their benefits over conductors and trying to improve upon these qualities.
CO3	Students will gain an understanding of dielectric material, their properties and use of dielectric material in capacitor. It will help in understanding about Capacitors, as it is one of the most basic electrical components in any electronic circuit.
CO4	Students will gain an understanding of different kinds of magnetic material and it uses.
CO5	Students will be able to evaluate the optical properties of the material and will create own understanding approaches to the finding them.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Elementary Lattice Dynamics	Elementary Lattice Dynamics: Lattice vibrations and phonons. Linear monoatomic and diatomic chains, Acoustical and optical phonons, Qualitative description of the phonon spectrum in solids, Dulong and Petit's law, Einstein and Debye theories of specific heat of solids, T^3 law.	08	CO1
2	Semiconductor Physics	Classifying materials as semiconductors, Chemical bonds in semiconductors, Mechanism of current flow, Forbidden, valence and conduction bands, Intrinsic and extrinsic semiconductors, Carrier concentration and Fermi level for intrinsic semiconductor, Carrier concentration, Fermi level and conductivity of extrinsic semiconductor.	08	CO2
3	Dielectric Properties of Materials	Polarization, Depolarization field, Electric susceptibility, Polarizability, Sources of polarizability (electronic, ionic, dipolar and orientational), Classical theory of electric polarizability, Frequency dependence of ionic polarizability, Local electric field at an atom, Clausius-Mosotti equation, Langevin-Debye equation, Complex dielectric constant and loss.	08	CO3
4	Magnetic Properties of Materials	Magnetic properties of matter: dia, para, ferri and ferromagnetic materials, Classical Langevin theory of dia and paramagnetic materials, Quantum mechanical treatment of paramagnetism, Curie law, Weiss's theory of ferromagnetic domains, Discussion of B-H Curve, hysteresis and energy loss.	08	CO4
5	Optical Properties of Materials	Classical Model-Drude model, ionic conduction, Optical refractive index and relative dielectric constant, Optical absorption in metals, semiconductors and insulators, Colour centres, Excitons, Luminescence, LED, Photo detector, Photomultiplier.	08	CO5

Reference Books:

1. Introduction to Solid State Physics by Charles Kittel (Willey Publication).
2. Elements of Solid-State Physics by Puri and Babbar (S. Chand).
3. Solid State Physics by S. O. Pillai (New Age International).

e-Learning Source:

1. https://nptel.ac.in/courses/115/104/115104109/
2. https://nptel.ac.in/courses/115/105/115105099/
3. https://nptel.ac.in/courses/113/107/113107075/
4. https://nptel.ac.in/courses/115/101/115101007/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3		1		1	2		3	3	2	1
CO2	3		2		3	2	2	3	3	2	1
CO3	3		2		3	2	2	3	3	2	1
CO4	3		1		2	2	2	3	3	2	1
CO5	3		2		3	2	2	3	3	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: 2018-19							
Course Code	**MT305**	**Title of the Course**	**Statics & Dynamics**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Mathematics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart basic and key knowledge of motion of body on various type of surfaces. Students will be able to learn about equilibrium and bodies acted upon by forces under different conditions. After successful completion of course, the student will be able to explore subject into their respective dimensions.						

Course Outcomes	
CO1	Students will be able to understand Velocity and acceleration along radial and transverse directions and along Tangential and normal directions. They will also study Simple harmonic motion in various situations and about Motion under other laws of forces, Earth attraction, Elastic strings.
CO2	Students will gain an understanding of Motion of bodies in resisting medium, Constrained motion (circular and cycloidal only).
CO3	Students will gain an understanding of motion of particle on smooth and rough plane curves, Rocket motion and also study about Central orbits and Kepler's law, Motion of a particle in three dimensions.
CO4	Students will create the own understanding of Common catenary, Centre of gravity and get knowledge of Stable and unstable equilibrium, Virtual work.
CO5	Students will learn about Forces in three dimensions, Poinsot's central axis, Wrenches, Null line and null plane.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Velocity and acceleration along radial and transverse directions, and along Tangential and normal directions, Simple harmonic motion, Motion under other laws of forces, Earth attraction, Elastic strings	8	1
2		Motion in resisting medium, Constrained motion (circular and cycloidal only).	8	2
3		Motion on smooth and rough plane curves, Rocket motion, Central orbits and Kepler's law, Motion of a particle in three dimensions.	8	3
4		Common catenary, Centre of gravity, Stable and unstable equilibrium, Virtual work.	8	4
5		Forces in three dimensions, Poinsot's central axis, Wrenches, Null line and null plane.	8	5

Reference Books:

1 R.S. Verma - A Text Book on Statics., Pothishala Pvt. Ltd., Allahabad

2. S.L. Loney - An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies, Kalyani Publishers, New Delhi.

3. J.L. Synge & B.A. Griffith - Principles of Mechanics, Tata McGraw-Hill, 1959.

4. M.A. Pathan: Statics

5. Jhonson and Beer: Vector Mechanics for Engineers

6. Zafar Ahsan: Lectures Notes on Mechanics

e-Learning Source:

1. https://nptel.ac.in/courses/112/106/112106180/
2. https://www.mathcity.org/bsc/notes_of_mechanics/tariq_mahmood_qadri
3. https://www.fisica.net/mecanicaclassica/introduction_to_statics_and_dynamics_by_rudra_pratap.pdf
4. https://www.msuniv.ac.in/Download/Pdf/2c2167ab44cf4fc

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	2	1	1	1	2	2	2	1	2	2
CO2	3	2	2	1	1	1	2	3	3	2	2	1
CO3	3	2	2	1	1	1	2	2	2	2	3	3
CO4	3	2	2	1	1	1	2	2	2	3	3	2
CO5	3	2	2	1	1	1	2	2	2	3	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: 2018-19							
Course Code	**MT306**	**Title of the Course**	**Analysis**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**3**	**1**	**0**	**4**
Pre-Requisite	B. Sc. Second year	**Co-requisite**					
Course Objectives	1. This is an introductory course on analysis for mathematics students. The aim of this course is to introduce and develop basic analytic concepts of limit, convergence, integration and differentiation. 2. This course is aimed to provide an introduction to the theories for functions of a complex variable. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions are then introduced.						

Course Outcomes	
CO1	Describe fundamental properties of the real numbers that lead to the formal development of real analysis.
CO2	Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration;
CO3	Understand and be able to use notions of convergence involving sequences of functions, including the difference between pointwise and uniform convergence. Apply the Weierstrass M-test and the uniform convergence theorem for integrals to examples.
CO4	Demonstrate understanding of the basic concepts underlying complex analysis.
CO5	Find Laurent series about isolated singularities, and determine residues and use the residue theorem to compute several kinds of real integrals.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Find Laurent series about isolated singularities, and determine residues and use the residue theorem to compute several kinds of real integrals.	8	1
2		Sequence of real numbers, Subsequence, Bounded and monotonic sequences, Convergent sequences, Cauchy's theorems on limit, Cauchy sequence, Cauchy general principle of convergence.	8	2
3		Uniform convergence of sequences and series of functions, Weierstrass - M test, Abel's and Dirichlet's test, Boundedness and intermediate value properties of continous functions, Uniform continuity, Meaning of sign of derivative, Darboux theorem	8	3
4		Functions of Complex variables, Limit, Continuity and differentiability, CR – equations, Analytic functions, Harmonic functions, Construction of analytic function.	8	4
5		Cauchy fundamental theorem, Cauchy integral formula, Derivatives of analytic functions, Morera's and Lioville's theorem, Zeros of analytic function, Singularities, Residues and theorem of Residue.	8	5

Reference Books:

1. Robert G. Bartle and Donald R. Sherbert : Introduction to Real Analysis,Wiley Student Edition.
2. S. C . Malik and S. Arora : Mathematical analysis, Wiley Eastern Ltd.
3. R . V. Churchill and J.W. Brown: Complex Variable & Applications, McGrow Hill, International Book Company, London
Goyal and Gupta : Function of a Complex Variable, Pragati Prakashan.

e-Learning Source:

1. https://swayam.gov.in/nd1_noc20_ma03/preview
2. https://www.youtube.com/watch?v=gJ1pYz1k0qM
3. https://www.youtube.com/watch?v=t9xW7UaZwZ0

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	1	2	1	1	1	1	2	2	2
CO2	3	1	2	1	3	1	1	2	2	1	2	3
CO3	3	1	2	1	3	1	1	1	2	1	2	3
CO4	3	1	1	1	2	1	1	2	2	2	3	3
CO5	3	1	1	1	2	1	1	2	2	3	3	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: 2018-19							
Course Code	**MT307**	**Title of the Course**	**BASIC MATHEMATICAL MODELING**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Mathematics	**Co-requisite**					
Course Objectives	The course is aimed to develop the skills in mathematics specially in calculus which is necessary for grooming them into successful science graduate. The topics introduced will serve as basic tools for specialized studies in science field.						

Course Outcomes

CO1	Assess and articulate what type of modeling techniques are appropriate for a given physical system.
CO2	Construct a Mathematical model of a given physical system and analyze it.
CO3	Make predictions of the behavior of a given physical system based on the analysis of its Mathematical Model.
CO4	Demonstrate understanding of powerful mathematical tools such as calculus of several variables, differential equations and elementary dynamical systems theory
CO5	Recognize the power of mathematical modeling and analysis and be able to apply their understanding to their further studies.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Simple situations requiring mathematical modeling, techniques of mathematical modeling, classifications of mathematical modeling, characteristics of mathematical models. Mathematical modeling through geometry, algebra, trigonometry and calculus. Limitations of methodical modeling.	8	1
2		Mathematical modeling through ordinary differential equations first order linear growth and decay models, compartment models, mathematical modeling in dynamics through first order ODE. Mathematics modeling through Systems of ODE of first order	8	2
3		Mathematical modeling in population dynamics, mathematical modeling of epidemic, Compartment model through system of ODE. Mathematical Modeling of circular motion, Planetary motions and motions of satellite.	8	3
4		Mathematics modeling in economics, in medicine, Arms race, Battles, international trade in terms of system of ODE and dynamic through ordinary differential equations. Mathematical Modeling through ODE of second order.	8	4
5		Mathematical modeling through difference equations: The need, basic theory, modeling in Economics and finance, modeling in population dynamics and Genetics, Modeling in probability theory. Examples of Mathematical modeling through difference equations	8	5

Reference Books:

1. Robert G. Bartle and Donald R. Sherbert : Introduction to Real Analysis,Wiley Student Edition.
2. S. C . Malik and S. Arora : Mathematical analysis, Wiley Eastern Ltd.
3. R . V. Churchill and J.W. Brown: Complex Variable & Applications, McGrow Hill, International Book Company, London
Goyal and Gupta : Function of a Complex Variable, Pragati Prakashan.

e-Learning Source:

1. https://www.youtube.com/watch?v=-uCwgZUz51o
2. https://nptel.ac.in/courses/111107113/
3. https://study.com/academy/lesson/types-of-mathematical-models.html
4. https://www.frontiersin.org/articles/10.3389/fgene.2015.00354/fullpdf
5. https://www.youtube.com/watch?v=jV4Hlh8gHLs

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	1	3	1	1	1	2	2	1
CO2	2	2	2	1	1	2	2	2	1	1	2	3
CO3	3	2	3	1	1	2	1	2	2	1	2	3
CO4	3	2	3	1	1	3	2	2	2	1	2	3
CO5	3	2	1	1	1	2	1	2	2	3	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: 2018-19							
Course Code	**MT308**	**Title of the Course**	**Linear Programming**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Mathematics	**Co-requisite**					
Course Objectives	To teach the basic concepts of Linear Programming, Integer Linear Programming, Multi-objective and Stochastic linear programming. To make students able for Post optimal analysis and optimal decision making problem. This is a great beginner course for those interested in Mathematical Programming Optimization.						

Course Outcomes	
CO1	Formulation of real life problems in the form of linear programming problem and various method to solve the formulated LPP.
CO2	Can obtain the problem when changing the parameters of the problem in later stages.
CO3	Understanding pure and mixed integer programming problems with different methods of solving those problems.
CO4	Understand Multi-objective and Stochastic programming problem and various methods to make them deterministic in order to solve efficiently.
CO5	Learn decision making problems under various environment explicitly the theory of games.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Formulation of linear programming problem, simplex algorithm, Primal Dual relationship, Economical interpretation of the dual, Dual Simplex method. Revised simplex method. Bounded variable simplex method	8	1
2		Sensitivity Analysis: Change in values of objective function coefficient, Change in right hand side values, Change in coefficient of coefficient, Adding a new product and adding a constraint.	8	2
3		Integer programming formulation, all integers and mixed integer programming problems, Gomory's cutting plane algorithm, Branch and bound algorithm. Knapsack problem.	8	3
4		tochastic programming models, Chance constraints optimization, two stage problems. Goal Programming methods and applications.	8	4
5		Decision Theory: Introduction, Elements of decision problem, Types of decision making environment, Decision tree. Game Theory: Basic definitions, Two-person Zero-sum games, Pure and mixed strategy, Principle of Dominance, Graphical method, Solution of games by linear programming method.	8	5

Reference Books:

1. Mokhtar S. Bazara, John J. Jarvis "Linear Programming and Network Flows" Fourth Edition. WILEY A John Wiley & Sons, Inc., Publication.
2. H.A. TAHA "Operations Research- An Introduction" Pearson.
3. K.Swarup, P.K.Gupta and A. Manmohan, "Operations Research", S. Chand.
4. Hiller And Liebarman, "Introduction to Operations Research", McGraw Hill Company.
5. David K. J. Mtetwa, "Linear Programming" Paradise publishers, US.

e-Learning Source:

1. https://www.youtube.com/watch?v=TwAvQJAM9Hk
2. https://www.youtube.com/watch?v=M8POtpPtQZc
3. https://www.youtube.com/watch?v=KLHWtBpPbEc
4. https://www.youtube.com/watch?v=o-N0jFUpdWo
5. https://www.youtube.com/watch?v=56-iiZEjqnU
6. https://www.youtube.com/watch?v=LAC212ZwBB4
7. https://www.youtube.com/watch?v=gkm6WljmbOk
8. https://www.youtube.com/watch?v=EyVYAngxkPA

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	2	1	3	1	1	1	2	2
CO2	3	1	1	1	2	1	3	2	2	3	2	3
CO3	3	1	1	2	2	1	3	2	2	2	2	3
CO4	3	2	3	1	1	1	3	2	1	1	2	3
CO5	3	2	1	2	2	1	3	2	3	3	3	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	**EC325**	**Title of the Course**	**Measurement Instrumentation & Transducers**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	**Sixth**	**3**	**1**	**0**	**4**
Pre-Requisite	Basic Electronics Engineering	**Co-requisite**					
Course Objectives	**1.** To explain the basic concepts and definitions in measurement. **2.** To describe the bridge configurations and their applications. **3.** To explain the measurement of non-electrical quantity, their working principle and construction. **4.** To elaborate the discussion about the importance of signal generators and analyzers in Measurement.						

Course Outcomes	
CO1	To understand the different measurement standards, systems and Errors in an electronic measurement system, transducers and their classification.
CO2	To analyze the different types of DC and AC bridges and high frequency measurement.
CO3	To understand the measurement of non electrical quantities along with their basic construction and working principle.
CO4	To understand the measurement of Amplifier and Receiver Characteristics, principle and working of telemetry tracking and command .
CO5	To understand the different types of signal generations ,their applications in the instruments and to understand the different analyzers.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Electronic Instrument Systems	Standards of Measurement of Mass, Length, Volume, Time and Frequency, Electrical Standards, Standards of Temperature and Luminous Intensity, IEEE standards, Engineering Analysis of Instrument Systems, Experimental Errors, Minimization of Errors, Frequency Response and Calibration of Instruments systems.Transducers: Classification: Displacement, Resistive, Capacitive, Inductive, Piezo-Electric, piezo-Resistive and Photo-Electric Transducers, Crystal Oscillator, Semiconductor Transducers.	8	1
2	Bridge Measurements	Wheatstone Bridge, Kelvin Bridge, Guarded Wheatstone Bridge, AC Bridges: Maxwell Bridge, Hay Bridge, Schering Bridge, Wien Bridge.High Frequency Measurements: Problems in High Frequency Measurement, RF Power and Voltage Measurements, RF Impedance Measurement, Q Meter, Digital Voltmeter, Time, Frequency and Phase Measurements, Measurement on CRO, Group Delay Measurement, Digital Storage Oscilloscope.	8	2
3	Measurement of Non Electrical Quantities	Measurement of Temperature: Resistance Thermometer, Thermocouple, IC Sensor, Radiation Method (Pyrometer) Measurements of Pressure, Fluid Flow, Force, Torque, Displacement, Velocity and Acceleration.	8	3
4	Miscellaneous Topics	Measurement of Amplifier and Receiver Characteristics, Data Distribution and Bus Structure, RS-232, IEEE488 Interface, PC Based Acquisition System, Data Transmission, D to A and A to D convertors, pulse Modulation Techniques. Telemetry, Tracking and Command.	8	4
5	Signal Generation	Frequency Synthesized Signal Generator, Frequency Divider Generator, Signal Generation Modulation, Sweep Frequency Generator, Pulse and Square wave Generators, Function Generator. Display Devices, Signal Analyzer, wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer. Microprocessor Based Instrumentation, Computer Controlled Test System, Fiber Optic Measurements.	8	5

Reference Books:

1. E.O. Doeblin/ Measurement Systems/ Mc Graw Hill
2. Oliver & J.M. Cage/Electronic Measurement and Instrumentation/ Mc Graw Hill.
3. Ranjan C.S./Instrumentation Devices & Systems / Tata Mc Graw Hill.

e-Learning Source:

1. https://nptel.ac.in
2. www.youtube.com

	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**
CO1	3	3	2	1	1	1	3						1	1		
CO2	3	3	3	2	1	1	3									
CO3	3	3	3	2	1	1	3						1			1
CO4	3	3	3	2	1		3									
CO5	3	3	2	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:							
Course Code	**EC326**	**Title of the Course**	Integrated Circuits	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	3	1	0	4
Pre-Requisite	EC222	**Co-requisite**	NA				
Course Objectives	To understand the basic concepts of the circuit configuration for the design of linear integrated circuits and develops skill to solve engineering problems. Perform signal amplification through BJT and MOS and learn the emitter resistance in differential amplifier replaced by constant current source. To understand the concept of MOSFET and apply the same to understand the MOS characteristics and model various MOS based circuits. To understand and develop analytical capability to analyze feedback in amplifiers and apply it to check the stability of feedback amplifiers and analyze multistage and tuned amplifiers. To understand the concept of Oscillators and analyze the working of different oscillators. To study the concept of regulated power supply and study various circuits for generating regulated power supply.						

Course Outcomes	
CO1	To understand the basic concepts of the circuit configuration for the design of linear integrated circuits and develops skill to solve engineering problems
CO2	Perform signal amplification through BJT and MOS and learn the emitter resistance in differential amplifier replaced by constant current source.
CO3	Student will be able to design mathematical operation using op-amp and OTA.
CO4	Student will be able to design analog multipliers circuit and perform multiplication and division operation and generate the square waveform using Multivibrators.
CO5	Student will be able to design the logic gates using TTL,ECL and IIL. Student will be able to design the power supply circuit.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Unit I	Review of Basic Integrated Circuits: Bipolar, NMOS, CMOS and BiCMOS, use of composite structure, cross-section, layout and equivalent circuit for Darlington pair, Differential pair, Multimeter and Multicollector for BJT.	8	1
2	Unit II	Mirror Curents ,BJT and MOS single stage analog amplifiers, differential amplifiers current mirrors and active loads, Widlar, cascaded and Wilson current source, current sources as active loads, Multistage amplifiers, gain and frequency response of the Differential amplifier and other characteristics.	8	2
3	Unit III	Operational Transconductance Amplifier (OTA). BJT Operational Amplifier, DC analysis and AC analysis of the 741 Op Amp, gain and frequency response, slew rate. Two satge MOS operational amplifier, CMOS Op Amp design, Folded-Cascade load. IC Operational Tranconductance Amplifier (OTA) using BJT and CMOS, Applications of Op Amp and OTA, Active Filters	8	3
4	Unit IV	Multipliers: Analog Multiplier with BJT Gilbert Multiplier (GM) cell. GM cell as a Balanced Modulator and Phase detector. Analog Multiplier using NMOS/CMOS devices, Voltage Controlled Oscillator, ICPLL 560,565, BJT/CMOS Bistable Multivibrators and Schmitt Trigger. BJT/CMOS Monostable and Astable circuits, crystal controlled square wave generators, IC Timer (555) as a Monostable, Astable Multivibrators.	8	4
5	Unit V	Logic Families: Formation of basic logic gates (TTL,ECL,IIL)and study of their input-output characteristics, interfacing between logic families, Data Converter ICs, Sample and Hold circuit, IC Voltage Regulators, Circuit analysis of 723 and 78/79.	8	5

Reference Books:

1. A. S. Sedra and K. C. Smith, Microelectronics Circuits, Oxford University Press, Sixth Edition
2. Gayakwad, Op Amps and Linear Integrated Circuits, Forth Edition, PHI.

e-Learning Source:

B. Razavi, Design of Analog CMOS Integrated Circuits, Mc Graw-Hill Int.Ed.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1		3	1	1	1		1	3
CO2	3	1	1		2	2	3	2		1	3
CO3	3	2	2		3	3	2	3		2	3
CO4	3	2	1		1	2	3	3		3	3
CO5	3	2	1		3	1	2	2		1	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:							
Course Code	EC327	**Title of the Course**	Image Processing and Its Applications	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**3**	**1**	**0**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	To learn how to represent grayscale, binary and color image in mathematical form, need of compression and its application and how to understand & apply it into the latest technology.						

Course Outcomes	
CO1	Students shall be able to understand the actual view in 2D image form and represent 2D image into mathematical form, able to understand the basic difference between gray image, color image and binary image.
CO2	For a given image, student shall be able to analyze it by applying using enhancement, restoration and segmentation techniques.
CO3	For a given image, student shall be able to understand the difference between lossless and lossy compression. Further they will be Examine and analyze the compression techniques like Huffman Coding, Arithmetic coding, Transform Coding: JPEG.
CO4	Students shall be able to understand the Image Processing & its Applications
CO5	Student shall be able understand about how to apply it in various field of Cyber Crime Laws

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Basic of Digital Images	Digital/Analog Image, Elements of digital/analog image processing system, Gray Image, Color Image, Binary Image, Conversion between Color Image and Gray Scale Image, Human Visual System (HVS).	8	CO1
2	Fundamentals of Image Processing	Histogram, Histogram Equalization, 2D Convolution, Low Pass Noise Filter, Edge Detection, Image Enhancement, Restoration and Segmentation.	8	CO2
3	Image Compression	Image Redundancies, Lossless v/s Lossy Compression, Huffman Coding, Arithmetic coding, JPEG.	8	CO3
4	Image Processing Applications	Medical Imaging, Finger Print, Iris and Face Detection, CCTV system, Watermarking Barcodes, (Visible/Invisible), Image Forensics.	8	CO4
5	Cyber Crime Laws	Unauthorized computer access, data theft, data modification, data manipulation, threatening e-mails, credit card frauds, telecommunication frauds, money laundering, software piracy, copy right violation.	8	CO5

Reference Books:

1. Kenneth R. Castleman, Digital Image Processing, Pearson India.
2. A.K. Jain, Image Processing, PHI India.
3. S. Jayaraman, Digital Image Processing, Tata McGraw - Hill Education Pvt. Ltd.
4. Gonzalez R.C. & P. Wint, Digital Image Processing, Addison Wesley.

e-Learning Source:

1. Digital Image Processing - Course (nptel.ac.in)
2. Image Signal Processing - Course (nptel.ac.in)

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2		1					2	1	1	
CO2	3	3				1		2			2
CO3	2	2	2					1	1		
CO4	2	3		3				1		1	3
CO5	3		1					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	**EC328**	**Title of the Course**	**Mobile Communication**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	**Sixth**	3	1	0	4
Pre-Requisite	NA	**Co-requisite**	NA				
Course Objectives	• To study the Evolution of wireless systems, concept of propagation, reflection, diffraction, scattering, propagation models, multipath fading, types of fading. • To study the concept of Mobile communication like channels description, mobile call, frequency reuse, handoff strategies, co channel and adjacent channel interferences, improving coverage and capacity in cellular systems, cell splitting, sectoring, microcell zone. • To study of Multiple access techniques : SDMA, FDMA, TDMA, CDMA • To understand the concept of Network Synthesis of RC, LC and Networks using Cauer's and Foster's first and second form . • • To study of Wireless networks: ATM, Paging, WLL, Bluetooth, RFID and Wireless Systems & Standards : GSM, CDMA2000, WCDMA, 3G systems, UMTS.						

Course Outcomes	
CO1	Students will be able to explain evolution of wireless systems, RF propagation and concept of reflection, diffraction, scattering, propagation models, fading.
CO2	Students will be able explain the concept of Mobile communication: Mobile channels, frequency reuse, handoff strategies of cell splitting, sectoring, microcell zone
CO3	Students will be able to explain the Multiple access techniques: SDMA, FDMA, TDMA and CDMA and able to analyze the spectrum efficiency of SDMA, FDMA, TDMA
CO4	Students will be able to explain the wireless networks: ATM, paging, WLL, Bluetooth , RFID
CO5	Students will be able to explain the architecture and features of GSM, CDMA2000,WCDMA,3G System and UMTS

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Evolution of wireless systems	RF propagation, reflection, diffraction, scattering, propagation models, multipath fading, types of fading, Introduction to 1G,2G,3G & 4G systems.	8	1
2	Mobile communication concepts	Mobile channels description, mobile call, frequency reuse, handoff strategies, co channel and adjacent channel interferences, improving coverage and capacity in cellular systems, cell splitting, sectoring, microcell zone.	8	2
3	Multiple access techniques	SDMA, FDMA, TDMA, CDMA & it's spectrum efficiency.	8	3
4	Wireless networks	ATM, Paging, WLL, Bluetooth, RFID.	8	4
5	Wireless Systems & Standards	GSM, CDMA2000, WCDMA, 3G systems, UMTS.	8	5

Reference Books:

1. William C.Y.Lee, "Mobile cellular telecommunications Analog & Digital systems", Tata Mc Graw Hill, India.
2. Pandya, "Mobile & personal communication Services & system", Prentice Hall of India.

e-Learning Source:

1. https://archive.nptel.ac.in/courses/117/104/117104099/
2. https://archive.nptel.ac.in/courses/117/105/117105148/
3. https://archive.nptel.ac.in/courses/117/104/117104115/

	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					
CO2	3	1				1	1						1					
CO3	3	1				1	2						2					
CO4	3	1				1	2						1					
CO5	3	1				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	PY310	**Title of the Course**	**C. V. Raman: Journey to Nobel Prize (Elective 3)**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The main objective of this course is to familiarize students with C. V. Raman, a great Indian physicist who got a Nobel prize for the Raman Effect, and how his life is a role model and motivation to the younger generation.						

Course Outcomes	
CO1	Students will be familiarized with the family background and education of sir CV Raman and his interest in reading and research at a very young age.
CO2	Students will know about the Awards and Honours (Nobel, Professorships and Honorary doctorates, etc.) conferred on him.
CO3	Students will understand the fascination of C V Raman towards waves and sounds – Research on musical instruments like Violin and Ektara, Veena, etc.
CO4	Students will be able to describe classical and quantum mechanical theories of the Raman effect. And also Know about pure rotational, vibrational, and vibrational-rotational Raman spectra.
CO5	Students will understand the applications of The Raman effect and use it in their daily life.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Life History of Sir C. V. Raman	Introduction to family background, education, detailed description of Raman's educational and professional achievements, career as a professor of physics, personal life, Outline the subject of the first research Raman conducted in the Indian Association for the Cultivation of Science (IACS), Kolkata.	08	CO1
2	Honors and Awards	A fellow of the Royal Society and knighted, Nobel Prize in Physics, The Franklin honour, The Bharat Ratna, Postal Stamps, and National Science Day, Raman's Research Center at Bangalore	08	CO2
3	Scientific Contribution	First to investigate the harmonic nature of the sound of Indian drums such as a table, Raman-Nath Theory, Raman and his student Suri Bhagavantam discovery, Raman works in collaboration with K. S. Krishnan, Blue Color of the Sea	08	CO3
4	The Raman Effect	The classical theory of Raman effect, Quantum theory of Raman effect, Pure Rotational Raman spectra, Vibrational Raman spectra, Vibrational - Rotational Raman spectra, Selection Rules in Raman spectroscopy, Mutual Exclusion Principle, Complementary nature of Raman and IR spectra.	08	CO4
5	Applications of the Raman Effect	Raman effect as the Physicist's tool, Raman effect as the Chemistry tool, Principle and types of Raman spectroscopy.	08	CO5

Reference Books:

1. "THE RAMAN EFFECT" by the National Historic Chemical Landmarks program of the American Chemical Society in 1998.
2. The Raman Effect: Applications, A. Anderson, 1971
3. Why the Sky is Blue: Dr. C.V. Raman Talks about Science, by C. V. Raman, Tulika Books, 2010
4. Journey Into Light: Life and Science of C.V. Raman, Ganesan Venkataraman, Indian Academy of Sciences, 1988
5. Scientific Papers of C.V. Raman: Floral colours and visual perception, C. V. Raman, Indian Academy of Sciences, 1988
6. The Raman Effect: A Unified Treatment of the Theory of Raman Scattering by Molecules, Derek A. Long, Wiley Online Library, 2002.

e-Learning Source:

1. NDLI: Lecture 27 : Raman Effect (iitkgp.ac.in)
2. Fundamentals of Spectroscopy - Course (nptel.ac.in)

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

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

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