Integral University, Lucknow
Department of Mathematics & Statistics
Study and Evaluation Scheme (w.e.f. 2020-21)

B. Sc. (Physics, Mathematics, Statistics) **III[rd] year / V[th] Semester**

(Physics, Mathematics)

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Total	Credit	Total Credits	Attributes							SDG
				L	T	P	CT	TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
THEORIES																					
1	PY301	Elements of Quantum Mechanics, Atomic & Molecular Spectra	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
2	PY302	Classical Mechanics, Relativity & Statistical Physics	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
3	PY303	Solid State, Nuclear & Particle Physics	Core	2	1	0	40	20	60	40	100	2:1:0	3	√		√					
4	MT301	Advanced Calculus	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
5	MT318	Metric Space	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
6	MT303	Number Theory	Core	2	1	0	40	20	60	40	100	2:1:0	3	√		√					
PRACTICAL																					
7	MT319	MATLAB	Practical	0	0	2	40	20	60	40	100	0:0:1	1	√		√					
8	PY304	Advance Electricity & Magnetism Lab	Practical	0	0	2	40	20	60	40	100	0:0:1	1	√		√					
TOTAL				16	6	4	320	160	480	320	800	24	24								

CT = Class Test; **TA** = Teacher's Assessment,; **ESE** = End Semester Examination; **Sessional** = CT + TA; **Subject Total** = Sessional + ESE

Integral University, Lucknow
Department of Mathematics & Statistics
Study and Evaluation Scheme(w.e.f 2022-23)

B. Sc. (Physics, Mathematics, Statistics) **III[rd] year / V[th] Semester**

(Statistics, Mathematics)

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Total	Credit	Total Credits	Attributes							SDG
				L	T	P	CT	TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
THEORIES																					
1	MT309	Fundamental of Operations Research	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√					
2	MT310	Demography & Vital Statistics	Core	2	1	0	40	20	60	40	100	2:1:0	3	√		√				√	
3	MT313	General Linear Model	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√					
4	MT301	Advanced Calculus	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
5	MT318	Metric Space	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
6	MT303	Number Theory	Core	2	1	0	40	20	60	40	100	2:1:0	3	√		√					
PRACTICAL																					
7	MT319	MATLAB	Practical	0	0	2	40	20	60	40	100	0:0:1	1	√		√					
8	MT312	Operations Reasearch & Demography Lab	Practical	0	0	2	40	20	60	40	100	0:0:1	1	√	√	√					
		TOTAL		16	6	4	320	160	480	320	800	24	24								

CT = Class Test; **TA** = Teacher's Assessment,; **ESE** = End Semester Examination; **Sessional** = CT + TA; **Subject Total** = Sessional + ESE

Integral University, Lucknow
Department of Mathematics & Statistics
Study and Evaluation Scheme (w.e.f 2022-23)

B. Sc. (Physics, Mathematics, Statistics) **III[rd] year / V[th] Semester**

(Physics, Statistics)

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Total	Credit	Total Credits	Attributes							SDG
				L	T	P	CT	TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
THEORIES																					
1	PY301	Elements Of Quantum Mechanics, Atomic & Molecular Spectra	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					4
2	PY302	Classical Mechanics, Relativity & Statistical Physics	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					4
3	PY303	Solid State, Nuclear & Particle Physics	Core	2	1	0	40	20	60	40	100	2:1:0	3	√		√					4
4	MT309	Fundamental of Operations Research	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√					12
5	MT310	Demography & Vital Statistics	Core	2	1	0	40	20	60	40	100	2:1:0	3	√		√				√	12
6	MT313	General Linear Model	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√					12
PRACTICAL																					
7	PY304	Advance Electricity & Magnetism Lab	Practical	0	0	2	40	20	60	40	100	0:0:1	1	√		√					12
8	MT312	Operations Research & Demography Lab	Practical	0	0	2	40	20	60	40	100	0:0:1	1	√	√	√					12
TOTAL				16	6	4	320	160	480	320	800	24	24								

CT = Class Test; **TA** = Teacher's Assessment,; **ESE** = End Semester Examination; **Sessional** = CT + TA; **Subject Total** = Sessional + ESE

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: 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 $\int_a^\infty f(x)dx$, Camparison 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:2022-23							
Course Code	MT318	**Title of the Course**	Metric Space	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc (PMS) 2nd year	**Co-requisite**					
Course Objectives	This module introduces students to the concept of a metric space and presents the ideas of open and closed sets, convergence, continuity, completeness and compactness in this context. It provides a foundation for more advanced courses in Mathematical Analysis and a new perspective on many of the ideas studied in Real Analysis.						

Course Outcomes	
CO1	Understand and appreciate the concept of a metric space and be able to recognize standard examples.
CO2	Students will be able to decide whether given functions are or are not metrics.
CO3	Student will be familiar with the classify and explanation of open and closed sets, adherent points, convergent and Cauchy convergent sequences, complete spaces, compactness.
CO4	Successful students to identify the continuity of a function which is defined on metric spaces, at a given point and identify the set of points on which a function is continuous.
CO5	Students will gain an understanding of Stability of Metric space.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1		Definition and examples of metric spaces, Bounded and unbounded metric spaces, distance between sets, Diameter of set, Open and Closed balls, interior points and interior of sets, Open sets, Neighborhood of a point, Limit point of a set, Closure of a set, Boundary points and boundary of set, subspace of metric spaces.	08	1
2		Sequences and subsequence's in metric space, convergent and Cauchy's sequences, complete metric space, relation between completeness and closedness, Cantor intersection Theorem, Completion Theorem, dense sets.	08	2
3		Definition and Characterization of continuous functions, continuous functions on compact spaces. Homeomorphism.	08	3
4		Cover of metric space, Compact metric space, compact sets and their criterion, properties of compact sets, relation between compactness, completeness and closedness, Finite intersection property, sequential compactness.	08	4
5		Totally bounded spaces, seprated sets, Connected and disconnected metric spaces, properties of connected sets, continuity functions on connected space.	08	5

Reference Books:

Q. H. Ansari, Metric Spaces Including Fixed Point Theory and Set-valued Maps, Narosa Publishing House, New Delhi, 2010

P.K. Jain and K. Ahmad, Metric Space, Second Edition Narosa Publishing House, New Delhi, 2003

S. Kumaresan, Topplogy of Metric Spaces, Narosa Publishing House, New Delhi, 2011.

e-Learning Source:

https://meet.google.com/jac-txmf-mod, http://www.ma.huji.ac.il/~razk/iWeb/My_Site/Teaching_files/Chapter1.pdf

https://meet.google.com/jac-txmf-mod

https://www.math.ksu.edu/~agondem/Ab12-13Metric_files/Metric%20and%20topological%20spaces.pdf

https://meet.google.com/his-gwfq-jvj

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	1	1	3	3	3	1	3	3
CO2	3	1	2	1	2	1	3	3	2	1	3	3
CO3	3	1	2	1	2	1	3	3	3	1	2	3
CO4	3	1	1	1	1	1	3	3	3	1	3	2
CO5	3	1	1	1	2	1	3	3	3	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: 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 course. 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 factorization 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: 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: 2020-21							
Course Code	MT309	**Title of the Course**	Fundamental of Operations Research	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Maths	**Co-requisite**					
Course Objectives	The purpose of this undergratuate course is to impart basic and key knowledge of Operations Research. Understand the definitions and Formulation of linear programming problem and different optimization techniques. After successfully completion of course, the student will able explore subject into their respective dimensions.						

Course Outcomes	
CO1	Define Origin and characteristics of Operations Research (OR), Methodology of Operations Research, Types of Operations Research models.
CO2	Define and explain Euclidean space, Neighbourhood, Boundary points, closed set, open set, bounded set, Hyper plane, Half space, Polytope and Polyhedron, Simplex, Convex and concave sets, Convex linear combination, Vertex.
CO3	State and explain Definitions and Formulation of linear programming problem (LPP) Graphical method, Simplex method, Big-M method, Two Phase method, Primal & Dual problem.
CO4	State and describe Various method of finding initial basic feasible solution of transportation problem, Optimality criterion in transportation problem. Solution of assignment problem using Hungarian method
CO5	State and explain Basic assumptions, Processing of n-Jobs on 2-Machines, n-Jobs on 3-Machines and 2-Jobs on k-Machines. Replacement of items that deteriorate with time, Replacement of items that fails suddenly - Individual replacement policy and Group replacement policy.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Origin, definitions, and characteristics of Operations Research (OR), Methodology of Operations Research, Types of Operations Research models	08	1
2		Euclidean space, Neighbourhood, Boundary points, closed set, open set, bounded set, Hyper plane, Half space, Polytope and Polyhedron, Simplex, Convex and concave sets, Convex linear combination, Vertex.	08	2
3		Definitions and Formulation of linear programming problem (LPP) Graphical method, Simplex method, Big-M method, Two Phase method, Primal & Dual problem.	08	3
4		Various method of finding initial basic feasible solution of transportation problem, Optimality criterion in transportation problem. Solution of assignment problem using Hungarian method	08	4
5		**Sequencing:** Basic assumptions, Processing of n-Jobs on 2-Machines, n-Jobs on 3-Machines and 2-Jobs on k-Machines. **Replacement Problems:** Replacement of items that deteriorate with time, Replacement of items that fails suddenly - Individual replacement policy and Group replacement policy.	08	5

Reference Books:

H.A. TAHA "Operations Research- An Introduction" Pearson

K.Swarup, P.K.Gupta and A. Manmohan, "Operations Research", S. Chand.

Hiller And Liebarman, "Introduction to Operations Research", McGraw Hill Company.

J.K.Sharma, "Operations Research ", Pearson.

e-Learning Source:

https://www.youtube.com/watch?v=be9e-Q-jC-

https://www.youtube.com/watch?v=bQ5_PPRPjG4

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	3	1	1	1	1	1	3	3	3	2	3	1
CO2	3	1	2	1	2	1	3	3	3	3	3	2
CO3	3	1	2	1	2	1	3	3	3	3	3	2
CO4	3	1	1	1	1	1	3	3	3	3	3	2
CO5	3	1	1	1	2	1	3	3	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	MT310	**Title of the Course**	Demography & Vital Statistics	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**2**	**1**	**0**	**3**
Pre-Requisite		**Co-requisite**					
Course Objectives	To teach the basic concepts of Vital Statistics and Demography. To make students able to understand various types of birth, death rates and populations This is a great beginner course for those interested in studying population sciences.						

Course Outcomes

CO1	Understand various components of population theories, errors and completeness of data. Adjustment of age data and use of Myer and UN indices.
CO2	Ability to collect vital data and to identify the errors in census and registration data. Ability to measure population rate and ratio of vital events and various mortality rates
CO3	Ability to understand Stationary and Stable population, central and force mortality. Use and construction of Life Tables
CO4	Ability to use and construct Abridge Life Tables using different methods along with various fertility measures
CO5	Understand various measurements of population growth, GRR and NRR.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.	6	1
2		Introduction and sources of collecting data on vital statistics, errors in census and registration data Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.	6	2
3		Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life (Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables	6	3
4		Abridged Life Tables: Concept and construction of abridged life tables by Reed-Merrell method, Greville's method and King's Method. Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR).	6	4
5		Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR)	6	5

Reference Books:

Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd. 2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9thEdition, Wordpress.

Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.

Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3"Edition. Prentice Hall of India Pvt. Ltd.

Keyfitz N., Beckman John A.: Demography Through Problems S-Verlag New york.

e-Learning Source:

https://www.youtube.com/watch?v=Zk_r-t21F2c

https://www.youtube.com/watch?v=tNGaWLKe6G8&list=PLJqqB-5SByZyYiJ7RbJQfpyP5ahdeU10R

https://www.youtube.com/watch?v=qQ9UqCV79cM

https://www.youtube.com/watch?v=OotKZaMiFi8

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	1	1	3	3	3	3	2	3
CO2	3	1	2	1	2	1	3	3	3	3	3	3
CO3	3	1	2	1	2	1	3	3	3	3	2	3
CO4	3	1	1	1	1	1	3	3	3	3	2	2
CO5	3	1	1	1	2	1	3	3	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: 2022-23							
Course Code	MT313	**Title of the Course**	**General Linear Model**	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	To teach the concepts of single and multiple regression models. To make students able to understand one way and two-way ANOVA and ANOCOVA. This is a great course for those interested in studying advance concept of Linear Models.						

Course Outcomes	
CO1	Ability to understand and apply Gauss Markov Setup of Multiple Linear Regression.
CO2	Ability to fit and interpret the data in the form of linear equation.
CO3	Ability to perform one way ANOVA with fixed effect model.
CO4	Ability to perform two way ANOVA with fixed effect model.
CO5	Can check and Predict future values from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile & quantile plots.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1		Gauss-Markov set-up: Theory of linear estimation, Estimiability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.	08	1
2		Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation.	08	2
3		Analysis of variance: Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models.	08	3
4		Analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models.	08	4
5		Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots.	08	5

Reference Books:

1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.

e-Learning Source:

1. https://www.youtube.com/watch?v=PY-xznrFNPI
2. https://www.youtube.com/watch?v=sSWGTqEhZkQ

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	1	1	3	3	3	3	3	1
CO2	3	1	2	1	2	1	3	3	3	3	3	2
CO3	3	1	2	1	2	1	3	3	3	3	3	2
CO4	3	1	1	1	1	1	3	3	3	3	3	2
CO5	3	1	1	1	2	1	3	2	3	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	MT312	**Title of the Course**	Operations Research & Demography lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**2**	**1**
Pre-Requisite	10+2 with Mathematics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge in Operations Research & Demography through different experiments related to its theoretical course.						

Course Outcomes	
CO1	Able to evaluate solution by Simplex method
CO2	Able to evaluate solution by Two phase method and Big-M Method
CO3	Able to solve the problems based on Transportation and Assignment problem
CO4	Able to solve problems based on crude birth and death rate
CO5	Able to solve problems based on Gross reproduction rate

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1		Practical based on Simplex method.	4	1
2		Practical based on Big M Method.	4	2
3		Practical based on Transportation Problems.	4	3
4		Practical based on Assignment Problems.	4	3
5		Practical based on sequencing models.	4	3
6		Practical based Replacement models.	4	3
7		Practical based on crude birth rate (CBR).	4	4
8		Practical based on crude death rate (CDR).	4	4
9		Practical based on specific fertility rate (SFR).	4	5
10		Practical based on Gross reproduction rate (GPR).	4	5

Reference Books:

H.A. TAHA "Operations Research- An Introduction" Pearson.

K.Swarup, P.K.Gupta and A. Manmohan, "Operations Research", S. Chand.

Hiller And Liebarman, "Introduction to Operations Research", McGraw Hill Company.

J.K.Sharma, "Operations Research ", Pearson.

e-Learning Source:

https://www.youtube.com/watch?v=be9e-Q-jC-0

https://www.youtube.com/watch?v=bQ5_PPRPjG4

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	3	1	1	1	1	1	3	3	3	2	3	3
CO2	3	1	2	1	2	1	3	3	3	2	3	3
CO3	3	1	2	1	2	1	3	3	3	2	3	3
CO4	3	1	1	1	1	1	3	3	3	2	3	3
CO5	3	1	1	1	2	1	3	3	3	2	3	3

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

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

Integral University, Lucknow
Department of Mathematics & Statistics
Study and Evaluation Scheme(w.e.f 2020-21)

B. Sc. (Physics, Mathematics, Statistics) **III[rd] year / VI[th] Semester**

(Physics, Mathematics)

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Total	Credit	Total Credits	Attributes							SDG
				L	T	P	CT	TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
THEORIES																					
1	PY305	Applied Electronics	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
2	PY307	Mathematical Methods in Physics (Elective)	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
	PY308	Advanced Solid State Physics(Elective)	Core											√		√					
3	MT305	Statics & Dynamics	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
4	MT306	Analysis	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
5	MT307	Basic Mathematical Modelling (Elective)	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
	MT308	Linear Programming (Elective)	Core											√	√	√					
6	PY309	UG Physics Project	Core	0	0	8	0	0	0	200	200	0:0:4	4	√		√		√		√	
			Total	15	5	8	200	100	300	400	700	24	24								

CT = Class Test; **TA** = Teacher's Assessment,; **ESE** = End Semester Examination; **Sessional** = CT + TA; **Subject Total** = Sessional + ESE

Integral University, Lucknow
Department of Mathematics & Statistics
Study and Evaluation Scheme(w.e.f 2022-23)

B. Sc. (Physics, Mathematics, Statistics) **III[rd] year / VI[th] Semester**

(Statistics, Mathematics)

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Total	Credit	Total Credits	Attributes							SDG
				L	T	P	CT	TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
THEORIES																					
1	MT311	Theory of Estimation & Reliability	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
2	MT314	Econometrics (Elective)	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√					
	MT315	Official Statistics (Elective)	Core											√							
3	MT305	Statics & Dynamics	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
4	MT306	Analysis	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
5	MT307	Basic Mathematical Modelling (Elective)	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					
	MT308	Linear Programming (Elective)	Core											√	√	√					
6	MT316	Field Work (Data Collection & Analysis)	Core	0	0	8	0	0	0	200	200	0:0:4	4	√		√				√	
			Total	15	5	8	200	100	300	400	700	24	24								

CT = Class Test; **TA** = Teacher's Assessment,; **ESE** = End Semester Examination; **Sessional** = CT + TA; **Subject Total** = Sessional + ESE

Integral University, Lucknow
Department of Mathematics & Statistics
Study and Evaluation Scheme(w.e.f 2022-23)

B. Sc. (Physics, Mathematics, Statistics) **III[rd] year / VI[th] Semester**

(Physics, Statistics)

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Total	Credit	Total Credits	Attributes							SDG
				L	T	P	CT	TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
THEORIES																					
1	PY305	Applied Electronics	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					11
2	MT311	Theory of Estimation & Reliability	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					12
3	MT314	Econometrics (Elective)	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√					8
	MT315	Official Statistics (Elective)	Core											√							10
4	PY307	Mathematical Methods in Physics (Elective)		3	1	0	40	20	60	40	100	3:1:0	4	√		√					4
	PY308	Advanced Solid State Physics(Elective)	Core											√		√					12
5	PY309	UG Physics Project	Core	0	0	8	0	0	0	200	200	0:0:4	4	√		√		√		√	11
	MT316	Field Work (Data Collection & Analysis)	Core											√		√				√	9
6	PY306	Physics of Materials	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√					9
	MT317	Project Management & Network Flows	Core											√	√	√					
			Total	15	5	8	200	100	300	400	700	24	24								

CT = Class Test; **TA** = Teacher's Assessment,; **ESE** = End Semester Examination; **Sessional** = CT + TA; **Subject Total** = Sessional + ESE

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	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. Johnson 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	PO 4	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: 2022-23							
Course Code	MT311	**Title of the Course**	Theory of Estimation & Reliability	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	Probability Distributions	**Co-requisite**					
Course Objectives	The course objective is to learn the basic knowledge of different methods of estimation and apply these methods to estimate (point estimation and interval estimation) the unknown parameter of population by sample statistic also to learn the concept of reliability and its various functions						

Course Outcomes	
CO1	The students will be able to understand the basic concept of Point estimation: Estimator and Estimate, Characteristics of a good estimator: Unbiasedness, consistency, sufficiency and efficiency, Method of maximum likelihood and Properties of maximum likelihood estimators
CO2	The students will be able to explain and apply the Method of minimum Chi-square, Method of Least squares and method of moments for estimation of parameters, Problems and examples, Sufficient Statistics, Cramer-Rao inequality and its use in finding MVU estimators.
CO3	The students will be able to explain the Interval estimation: Distinction between point estimation and interval estimation -Confidence interval and confidence limits – Construction of confidence intervals for parameters of Binomial, Poisson, Normal, and Exponential distributions.
CO4	The students will be able to understand the Reliability concepts, quality and reliability, Reliability function, hazard rate function, bathtub curves, pdf form of hazard function, Reliability function and mean time to failure distribution with DFR and IFR, and censoring concepts.
CO5	The students will be able to explain and apply Coherent structures, representation of coherent systems in terms of paths and cuts, Modules of coherent systems, Reliability of system of independent components, series, parallel, k out of n series-parallel, parallel-series, and non series parallel configurations

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1		Point estimation: Estimator and Estimate, Characteristics of a good estimator: Unbiasedness, consistency, sufficiency and efficiency, Method of maximum likelihood and Properties of maximum likelihood estimators (without proof).	08	1
2		Method of minimum Chi-square, Method of Least squares and method of moments for estimation of parameters, Problems and examples, Sufficient Statistics, Cramer-Rao inequality and its use in finding MVU estimators.	08	2
3		Interval estimation: Distinction between point estimation and interval estimation -Confidence interval and confidence limits – Construction of confidence intervals for parameters of Binomial, Poisson, Normal, and Exponential distributions.	08	3
4		Introduction to Reliability concepts, quality and reliability, Reliability function, hazard rate function, bathtub curves, pdf form of hazard function, Reliability function and mean time to failure distribution with DFR and IFR, and censoring concepts.	08	4
5		Coherent structures, representation of coherent systems in terms of paths and cuts, Modules of coherent systems, Reliability of system of independent components, series, parallel, k out of n series-parallel, parallel-series, and non series parallel configurations.	08	5

Reference Books:

Rohatgi, V.K. (1988), An introduction to probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi.

Lehmann, E.L. (1986), Theory of point estimation (Student edition).

Hogg, R.V. and Craig, A.T. (1978) Introduction to Mathematical Statistics, Fourth Edition Collier Macmillian Publishers.

Mood, A.M., Graybill, F. a., and Bies, D.C. (1974), Introduction to the Theory of Statistics, Third Edition, McGrow Hill.

Rao, C.R. (1973), Linear Statistical Inference and its Applications, Revised Edition, Wiley Eastern Ltd., New Delhi.

e-Learning Source:

https://www.youtube.com/watch?v=WKPDZLus8Fo

https://www.youtube.com/watch?v=JmnmZB5VcyE

https://www.youtube.com/watch?v=k-eh0bnc_j0

https://www.youtube.com/watch?v=xnAuIbiLS8Y

	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	1	1	3	3	3	2	3	3
CO2	3	1	2	1	2	1	3	3	3	2	3	3
CO3	3	1	2	1	2	1	3	3	3	2	3	3
CO4	3	1	1	1	1	1	3	3	3	3	3	2
CO5	3	1	1	1	2	1	3	3	3	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: 2020-21							
Course Code	MT314	**Title of the Course**	Econometrics	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	The course objective is to learn the basic concept of Econometrics and how to construct the linear regression models and apply these models especially in the field of economical data for future prediction						

Course Outcomes	
CO1	The students will be able to understand the basic concept of Objective behind building econometric models, nature of econometrics, role of econometrics. General linear econometric model (GLM), Estimation.
CO2	The students will be able to explain and apply Estimation of model by method of ordinary least squares; properties of estimators; goodness of fit; tests of hypotheses; scaling and units of measurement; confidence intervals; Gauss-Markov theorem; forecasting
CO3	The students will be able to explain and evaluate the Estimation of parameters; properties of OLS estimators; goodness of fit - R^2 and adjusted R^2; partial regression coefficients;
CO4	The students will be able to describe the Individual and joint**;** functional forms of regression models; qualitative (dummy) independent variables.
CO5	The students will be able to understand and explain the Consequences, Detection and Remedies; Specific Analysis, Multicollinearity; heteroscedasticity; serial and biserial correlation. Omission of a relevant variable; inclusion of irrelevant variable; tests of specification errors.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Objective behind building econometric models, nature of econometrics, role of econometrics. General linear econometric model (GLM), Estimation	08	1
2		Estimation of model by method of ordinary least squares; properties of estimators; goodness of fit; tests of hypotheses; scaling and units of measurement; confidence intervals; Gauss-Markov theorem; forecasting	08	2
3		Estimation of parameters; properties of OLS estimators; goodness of fit - R^2 and adjusted R^2; partial regression coefficients;	08	3
4		Individual and joint**;** functional forms of regression models; qualitative (dummy) independent variables.	08	4
5		Consequences, Detection and Remedies; Specific Analysis, Multicollinearity; heteroscedasticity; serial and biserial correlation. Omission of a relevant variable; inclusion of irrelevant variable; tests of specification errors.	08	5

Reference Books:

D. N. Gujarati and D.C. Porter, *Essentials of Econometrics*, McGraw Hill, 4th edition, International Edition, 2009.

Christopher Dougherty, *Introduction to Econometrics*, Oxford University Press, 3rd edition, Indian Edition, 2007.

Jan Kmenta, *Elements of Econometrics*, Indian Reprint, Khosla Publishing House, 2nd edition, 2008.

e-Learning Source:

https://www.youtube.com/watch?v=Osxh2cKJXOA

https://www.youtube.com/watch?v=PR-4CPsVQZE

https://nptel.ac.in/courses/111/104/111104072/

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	1	1	3	3	3	3	3	2
CO2	3	1	2	1	2	1	3	3	3	3	3	2
CO3	3	1	2	1	2	1	3	3	3	3	3	2
CO4	3	1	1	1	1	1	3	3	3	3	3	2
CO5	3	1	1	1	2	1	3	3	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	MT315	**Title of the Course**	Official Statistics	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	The course objective is to learn the basic knowledge of official organizations and academic bodies where statistical data are collected and analyzed. These offices provide information to the government and government make the policies and different scheme for their citizen.						

Course Outcomes	
CO1	The students will be able to understand the Sources of official statistics, deficiencies, Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Government of India's Principal publications containing data on the topics such as population, agriculture, industry and finance
CO2	The students will be able to explain and apply the Various official agencies responsible for data collection and their main functions, Role of Ministry of Statistics & Program Implementation concept of CSO, National Sample Survey Office (NSSO), and National Statistical Commission
CO3	The students will be able to explain the Role, function and activities of central and state statistical organizations, state statistical bureau, organization of large scale sample surveys, general and special data dissemination systems
CO4	The students will be able to understand the Role, function and activities of Indian statistical institute, Indian agriculture statistics research institute, Indian institute of population studies, Institute of labour research, Statistical and economics departments of Reserve bank of India
CO5	The students will be able to explain Population growth in developed and developing countries, evaluation and performance of family welfare programs, projections of labour force and manpower, scope and content of population census of India

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Sources of official statistics, deficiencies, Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Government of India's Principal publications containing data on the topics such as population, agriculture, industry and finance	08	1
2		Various official agencies responsible for data collection and their main functions, Role of Ministry of Statistics & Program Implementation (MoSPI), concept of Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission	08	2
3		Role, function and activities of central and state statistical organizations, state statistical bureau, organization of large scale sample surveys, general and special data dissemination systems	08	3
4		Role, function and activities of Indian statistical institute, Indian agriculture statistics research institute, Indian institute of population studies, Institute of labour research, Statistical and economics departments of Reserve bank of India	08	4
5		Population growth in developed and developing countries, evaluation and performance of family welfare programs, projections of labour force and manpower, scope and content of population census of India	08	5

Reference Books:

Basic Statistics Relating to the Indian Economy (CSO), 1990.

Guide to Official Statistics (CSO) 1999.

Statistical System in India (CSO), 1995.

Principles and accommodation of National Population Censuses, UNESCO

Family Welfare Yearbook, Annual Publication of D/o Family Welfare.

Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.

e-Learning Source:

https://www.youtube.com/watch?v=Osxh2cKJXOA

https://www.youtube.com/watch?v=PR-4CPsVQZE

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	1	1	3	3	3	1	3	3
CO2	3	1	2	1	2	1	3	3	3	1	3	3
CO3	3	1	2	1	2	1	3	3	3	1	3	3
CO4	3	1	1	1	1	1	3	3	3	1	3	3
CO5	3	1	1	1	2	1	3	3	3	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	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**