B.Sc (Physics, Mathematics and Statistics)

Fifth Semester

1. Name of the Department: Mathematics						
2. Course Name	**Advanced Calculus**			**L**	**T**	**P**
3. Course Code	**MT301**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	10+2 with Mathematics	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. 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.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
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 used to 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 $\int_a^\infty f(x)dx$, Camparison test, convergence of $\int_a^\infty \frac{dx}{x^n}, a > 0$, Abel's test, Dirichlet's test, convergence of $\int_a^\infty \frac{dx}{(x-a)^n}$. They will also study convergence of beta and gamma functions.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit:**

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.

Unit-2	**Number of lectures =08**	**Title of the unit:**

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.

Unit-3	**Number of lectures = 08**	**Title of the unit:**

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.

Unit-4	**Number of lectures = 08**	**Title of the unit:**

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 .

Unit-5	**Number of lectures = 08**	**Title of the unit:**

Improper integrals, convergence of $\int_a^\infty f(x)dx$, Camparison test, convergence of $\int_a^\infty \frac{dx}{x^n}, a > 0$, Abel's test, Dirichlet's test, convergence of $\int_a^\infty \frac{dx}{(x-a)^n}$, convergence of beta and gamma functions.

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO**	**PO5**	**PO6**	**PO7**
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.	**3**	**2**	**2**	**1**	**1**	**1**	**2**
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.	**3**	**2**	**2**	**1**	**1**	**1**	**2**
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.	**3**	**2**	**2**	**1**	**1**	**1**	**2**
CO4	Students will create the own understanding and used to 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	**3**	**1**	**2**	**1**	**1**	**1**	**2**
CO5	Students will gain an understanding of solution of Improper integrals, convergence of $\int_a^\infty f(x)dx$, Camparison test, convergence of $\int_a^\infty \frac{dx}{x^n}, a \geq 0$, Abel's test, Dirichlet's test, convergence of $\int_a^\infty \frac{dx}{(x-a)^n}$. They will also study convergence of beta and gamma functions.	**3**	**1**	**2**	**1**	**1**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

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

13. B**ooks recommended:**

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.

1. Name of the Department: Mathematics						
2. Course Name	**Mathematical Statistics**			**L**	**T**	**P**
3. Course Code	**MT302**			2	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**DE ()**	**FC ()**		**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick**	Even ()	Odd (✓)		Every Sem ()

7. Total Number of Lectures, Tutorials		
Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. 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.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
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.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit:**

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

Unit-2	**Number of lectures =08**	**Title of the unit:**

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

Unit-3	**Number of lectures = 08**	**Title of the unit:**

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

Unit-4	**Number of lectures = 08**	**Title of the unit:**

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

Unit-5	**Number of lectures = 08**	**Title of the unit:**

Mathematical expectation, Probability mass function (pmf) and Probability density function (pdf). Binomial Probability distributions, Poisson Probability distributions, and Normal Probability distributions

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7

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	**2**	**2**	**3**	**2**	**2**	**2**	**2**
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	**3**	**3**	**2**	**2**	**2**	**3**	**2**
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	**2**	**2**	**3**	**3**	**2**	**2**	**2**
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	**2**	**2**	**2**	**3**	**2**	**2**	**1**
CO5	To understand Mathematical expectation, Probability mass function (pmf) and Probability density function (pdf). Binomial Probability distributions, Poisson Probability distributions, and Normal Probability distributions.	**2**	**3**	**2**	**3**	**2**	**2**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

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

13. Books recommended:

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

1. Name of the Department: Mathematics						
2. Course Name	**Number Theory**			**L**	**T**	**P**
3. Course Code	**MT303**			2	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	10+2 with PCM	**6. Frequency (use tick**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials						
Lectures = 22		**Tutorials = 10**		**Practical = Nil**		

8. 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.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
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
CO5	Can solve systems of Diophantine equations using the Chinese Remainder Theorem & the Euclidean algorithm and Lagrange's theorem

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit:**
Cartesian product of sets, Equivalence relation and partition, Fundamental theorem of equivalence of relation, Equivalence sets.		
Unit-2	**Number of lectures =06**	**Title of the unit:**
Cardinal numbers, power of continuum, cardinal arithmetic, Inequalities in cardinals, Cantor's theorem, Schrodar Berntien Theorem		
Unit-3	**Number of lectures = 06**	**Title of the unit:**
Division Algorithm, greatest common divisor, least common multiplier, prime number, unique factorisation theorem.		
Unit-4	**Number of lectures = 06**	**Title of the unit:**
Congruence, Complete residue theorem, Euler's theorem		
Unit-5	**Number of lectures = 06**	**Title of the unit:**
Linear congruence, Chinese remainder theorem, problem based on Chinese remainder theorem, Lagrange's theorem		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Can be able to demonstrate Cartesian product of sets, Equivalence relation and partition, Fundamental theorem of equivalence of relation, Equivalence sets.	**3**	**1**	**1**	**1**	**2**	**3**	**3**
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	**3**	**2**	**1**	**1**	**2**	**1**	**3**
CO3	Can analyse hypotheses and conclusions of mathematical statements of divisibility, congruence, greatest common divisor, prime, and prime	**2**	**2**	**1**	**1**	**2**	**1**	**3**
CO4	Can apply different techniques of congruence to verify mathematical assertions, including proof by induction, by contrapositive and by	**3**	**2**	**2**	**1**	**1**	**1**	**1**
CO5	Can solve systems of Diophantine equations using the Chinese Remainder Theorem & the Euclidean algorithm and Lagrange's theorem	**3**	**2**	**1**	**1**	**2**	**1**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

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

13. Books recommended:

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

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1. Name of the Department: Physics						
2. Course Name	**Elements of Quantum Mechanics, Atomic and**			**L**	**T**	**P**
3. Course Code	**PY301**			3	1	0
4. Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective**	
5. Pre-requisite (if any)	10+2 with Physics	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. 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.

9. COURSE OUTCOMES (CO):
After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
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.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: 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.

Unit-2	**Number of lectures =08**	

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,

Unit-3	**Number of lectures = 08**	

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.

Unit-4	**Number of lectures = 08**	**Title of the unit: 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.

Unit-5	**Number of lectures = 08**	**Title of the unit: 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.

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO 3**	**PO4**	**PO5**	**PO 6**	**PO7**

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.	**3**	**2**			**1**		**1**
CO2	Provided with the wavefunction of a system students would be able to normalize it and determine the expectation values.	**3**	**1**			**2**		**3**
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.	**3**	**1**			**2**		**3**
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.	**3**	**1**			**2**		**3**
CO5	To analyze the origin of electronic, vibrational and rotational energy levels and undertake simple calculations of energy levels.	**3**	**1**			**2**		**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Brief description of self learning / E-learning component

13. B**ooks recommended:**

1. H. S. Mani and G. K. Mehta; "Introduction to Modern Physics" (Affiliated East- West Press 1989).
2. A. Beiser, "Perspectives of Modern Physics (McGraw Hill).
3. H. E. White; "Introduction to Atomic Physics (D. Van Nostrand Company)
4. Barrow; "Introduction to Molecular Physics (McGraw Hill).
5. R. P. Feymann, R. B. Leighton and M. Sands; "The Feynman Lectures on Physics, Vol. III (B I Publications. Bombay. Delhi, Calcutta, Madras).
6. T. A. Littlefield and N Thorley; "Atomic and Nuclear Physics" (Engineering Language Book Society).
7. Eisenberg and Resnick; "Quantum Physics of Atoms, 'Molecules, Solids, Nuclei and Particles" (John Wiley).

1. Name of the Department: Physics						
2. Course Name	**Classical Mechanics, Relativity and Statistical**			**L**	**T**	**P**
3. Course Code	**PY302**			3	1	0
4. Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective**	
5. Pre-requisite (if any)	10+2 with Physics	**6. Frequency (use tick**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. 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.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
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.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit:** 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.

Unit-2	**Number of lectures =08**	

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.

Unit-3	**Number of lectures = 08**	

Probability and thermodynamic probability, principle of equal a priori probabilities, probability distribution and its narrowing with increase in number of particles.

Unit-4	**Number of lectures = 08**	**Title of the unit:** 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.

Unit-5	**Number of lectures = 08**	**Title of the unit:** 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.

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO**	**PO**	**PO6**	**P**
CO1	Students will gain an understanding of the Classical Mechanics and basic theories of Physics like Lagrangian and Hamiltonian Dynamics.	**3**	**2**	**1**	**1**		**1**	**2**
CO2	Students will be able to develop a deep understanding of various phenomena of Special Theory of Relativity and concept of mass-energy equivalence.	**3**	**2**	**1**	**1**		**1**	**2**
CO3	Students will be able to master basic statistical methods and concepts like probability, random variables, expected value, variance, estimators and common probability distributions.	**3**	**1**	**1**				**1**
CO4	Students will be able to write the distribution function of various systems and further calculate various thermodynamic potentials.	**3**	**1**				**2**	**1**
CO5	Interpretation of Maxwellian distribution. Analysis of statistical mechanical description of Fermi- and Bose- statistics for electron and photon.	**3**						**2**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Brief description of self learning / E-learning component

13. B**ooks recommended:**

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).
5. H. Goldstein, "Classical Mechanics, 2nd Edition (Narosa).

1. Name of the Department: Physics						
2. Course Name	**Solid State, Nuclear and Particle Physics**			**L**	**T**	**P**
3. Course Code	**PY303**			3	1	0
4. Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective**	
5. Pre-requisite (if any)	10+2 with Physics	**6. Frequency (use tick**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. 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 student will able explore subject into their respective dimensions

9. COURSE OUTCOMES (CO):
After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
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.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: 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.

Unit-2	**Number of lectures =08**	**Title of the unit: 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.

Unit-3	**Number of lectures = 08**	

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.

Unit-4	**Number of lectures = 08**	**Title of the unit: 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.

Unit-5	**Number of lectures = 08**	**Title of the unit: 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.

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO**	**PO5**	**PO6**	**P**
CO1	Students will be able to recognize the different crystal structures and understand basic crystallography.	**3**	**1**	**1**		**2**	**1**	**1**

CO2	Students will gain ability to describe the different physical mechanisms involved in crystal binding identifying the repulsive and attractive interactions and correlates these with the atomic	**3**	**1**	**2**		**3**	**1**	**1**
CO3	Students will apply the knowledge obtained to make a judicious choice of a solid in terms of its desired property.	**3**	**1**	**2**		**3**	**1**	**1**
CO4	Students will understand the basic properties of nucleus, Nuclear Forces and Nuclear Reactions.	**3**	**1**			**2**	**1**	
CO5	Students will gain basic knowledge of particle physics.	**3**	**1**			**2**	**1**	

3: Strong contribution, 2: Average contribution, 1: Low contribution

12. Brief description of self learning / E-learning component

13. Books recommended:

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).

1. Name of the Department: Physics						
2. Course Name	**Applied Electronics**			**L**	**T**	**P**
3. Course Code	**PY305**			3	1	0
4. Type of Course (use tick mark)		**Core ()**	**Foundation Course ( )**		**Departmental Elective (√)**	
5. Pre-requisite (if any)	10+2 with Physics	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. 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 student will able explore subject into their respective dimensions.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
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.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: 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.

Unit-2	**Number of lectures =08**	**Title of the unit: 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.

Unit-3	**Number of lectures = 08**	**Title of the unit: 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.

Unit-4	**Number of lectures = 08**	**Title of the unit: 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.

Unit-5	**Number of lectures = 08**	**Title of the unit: 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.

11. CO-PO Mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	Students will gain an understanding of modern physics and characterization of semiconductor based electronic devices.	**3**	**2**	**1**	**2**	**1**	**1**	**3**
CO2	Students will be able to realize the important concepts of advance electronics related to bipolar junction transistors.	**3**	**2**	**1**		**2**	**1**	**3**
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.	**3**	**2**	**1**		**2**	**1**	**3**
CO4	Students will learn about the high switching semiconducting devices like FETs and MOSFETs for designing power supplies for industrial and commercial applications.	**3**	**2**	**1**		**1**	**1**	**3**
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.	**3**	**2**	**1**	**1**	**2**	**1**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Brief description of self learning / E-learning component

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/

13. Books recommended:

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).

Core Courses

1. Name of the Department: Physics						
2. Course Name	**Physics of Materials**			**L**	**T**	**P**
3. Course Code	**PY306**			3	1	0
4. Type of Course (use tick mark)		**Core ()**	**Foundation Course ( )**		**Departmental Elective (√)**	
5. Pre-requisite (if any)	10+2 with Physics	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. 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.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
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

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: 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.

Unit-2	Number of lectures =08	Title of the unit: 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

Unit-3	Number of lectures = 08	Title of the unit: 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.

Unit-4	Number of lectures = 08	Title of the unit: 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.

Unit-5	Number of lectures = 08	Title of the unit: 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).

11. CO-PO Mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	To learn about crystal structure and its fractures	3	1	1		2	1	1
CO2	To introduce crystal imperfection and elastic properties of crystals.	3	1	2		2	1	1
CO3	To introduce the structure of metals, alloys, ceramics and glasses and their processing.	3	1	2		2	1	1
CO4	To Introduce the Nanomaterials and nanotechnology	3	1			2	1	
CO5	To learn various characterization techniques of nanoparticles or nanomaterials	3	1			2	1	

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Brief description of self learning / E-learning component

13. Books recommended:

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).
5. Materials Science and Engineering: V. Raghvan (Prentice Hall).
6. Elements of Materials Science and Engineering: L.H. Van Vlack (Addison-Wesley).
7. Introduction to Nanotechnology: Charles P. Poole Jr, Frank J. Owens.

1. Name of the Department: Physics						
2. Course Name	Advanced Solid-State Physics (Elective 2)			L	T	P
3. Course Code	PY308			3	1	0
4. Type of Course (use tick mark)		Core ()	Foundation Course ()		Departmental Elective (√)	
5. Pre-requisite (if any)	10+2 with Physics	6. Frequency (use tick marks)	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. 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.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
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.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: 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.

Unit-2	Number of lectures =08	Title of the unit: 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.

Unit-3	Number of lectures = 08	Title of the unit: Dielectric Properties of Materials

Polarization, Depolarization field, Electric susceptibility, Polarizability, Sources of polarizability (electronic, ionic, dipolar & 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.

Unit-4	Number of lectures = 08	Title of the unit: 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.

Unit-5	Number of lectures = 08	

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.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will gain an understanding of the dispersion relation for mono and diatomic lattice which determine how angular frequency varies with wave vector and the variation of specific heat with temperature.	3		1		1	2	
CO2	Students will be able to evaluate the band gap, carrier concentration and Fermi level of extrinsic and intrinsic semiconductor.	3		2		3	2	2
CO3	Students will create the own understanding of dielectric material and their properties and find the dielectric constant and loss.	3		2		3	2	2
CO4	Students will gain an understanding of different kinds of magnetic material and it uses.	3		1		2	2	2
CO5	Students will be able to evaluate the optical properties of the material and will create own understanding approaches to the finding them.	3		2		3	2	2

3: Strong contribution, 2: Average contribution, 1: Low contribution

12. Brief description of self learning /E-learning component

13. Books recommended:

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).

1. Name of the Department: Mathematics						
2. Course Name	**Statics & Dynamics**			**L**	**T**	**P**
3. Course Code	**MT305**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	10+2 with Mathematics	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. 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.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
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.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit:**
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		
Unit-2	**Number of lectures =08**	**Title of the unit:**
Motion in resisting medium, Constrained motion (circular and cycloidal only).		
Unit-3	**Number of lectures = 08**	**Title of the unit:**
Motion on smooth and rough plane curves, Rocket motion, Central orbits and Kepler's law, Motion of a particle in three dimensions.		
Unit-4	**Number of lectures = 08**	**Title of the unit:**

Common catenary, Centre of gravity, Stable and unstable equilibrium, Virtual work.

Unit-5	**Number of lectures = 08**	**Title of the unit:**

Forces in three dimensions, Poinsot's central axis, Wrenches, Null line and null plane.

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
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.	**3**	**2**	**2**	**1**	**1**	**1**	**2**
CO2	Students will gain an understanding of Motion of bodies in resisting medium, Constrained motion (circular and cycloidal only).	**3**	**2**	**2**	**1**	**1**	**1**	**2**
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.	**3**	**2**	**2**	**1**	**1**	**1**	**2**
CO4	Students will create the own understanding of Common catenary, Centre of gravity and get knowledge of Stable and unstable equilibrium, Virtual work.	**3**	**2**	**2**	**1**	**1**	**1**	**2**
CO5	Students will learn about Forces in three dimensions, Poinsot's central axis, Wrenches, Null line and null plane.	**3**	**2**	**2**	**1**	**1**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

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

13. B**ooks recommended:**

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

1. Name of the Department: Mathematics

2. Course Name	**Analysis**			**L**	**T**	**P**
3. Course Code	**MT306**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc Second year	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. 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.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
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 analyis.
CO5	Find Laurent series about isolated singularities, and determine residues and use the residue theorem to compute several kinds of real integrals.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Topological spaces**

Axiomatic study of real numbers, Completeness property in R , Archimedean property, Countable and uncountable sets, Neighborhood, Interior points, Limit points, Open and closed sets, Derived sets, Dense sets, Perfect sets, Bolzano – Weierstrass theorem.

Unit-2	**Number of lectures =08**	**Title of the unit: Homeomorphism and separation axioms**

Sequence of real numbers, Subsequence, Bounded and monotonic sequences, Convergent sequences, Cauchy's theorems on limit, Cauchy sequence, Cauchy general principle of convergence.

Unit-3	**Number of lectures = 08**	**Title of the unit: Compactness**

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

Unit-4	**Number of lectures = 08**	**Title of the unit: Connectedness**

Functions of Complex variables, Limit, Continuity and differentiability, CR – equations , Analytic functions, Harmonic functions, Construction of analytic function.

Unit-5	**Number of lectures = 08**	**Title of the unit: Product Topology**

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. .

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Describe fundamental properties of the real numbers that lead to the formal development of real analysis.	**3**	**1**	**1**		**2**	**1**	**1**
CO2	Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.	**3**	**1**	**2**		**3**	**1**	**1**
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.	**3**	**1**	**2**		**3**	**1**	**1**

CO4	Demonstrate understanding of the basic concepts underlying complex analyis.	**3**	**1**	**1**		**2**	**1**	**1**
CO5	Find Laurent series about isolated singularities, and determine residues and use the residue theorem to compute several kinds of real integrals.	**3**	**1**	**1**		**2**	**1**	**1**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

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

13. Books recommended:

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.

1. Name of the Department: Mathematics						
2. Course Name	**BASIC MATHEMATICAL MODELING**			**L**	**T**	**P**
3. Course Code	**MT307**			3	1	0
4. Type of Course (use tick mark)				**Core ()**	**DE (√)**	**FC ( )**
5. Pre-requisite (ifany)	+2 with Mathematics	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. 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.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
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.

10. Unit wise detailed content

Unit-1	**Number of lectures**	**08**
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.		
Unit-2	**Number of lectures**	**08**
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		
Unit-3	**Number of lectures**	**08**
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.		
Unit-4	**Number of lectures**	**08**
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.		
Unit-5	**Number of lectures**	**08**
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		

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	Assess and articulate what type of modeling techniques are appropriate for a given physical system.	**3**	**2**	**2**	**1**	**1**	**3**

CO2	Construct a Mathematical model of a given physical system and analyze it.	**2**	**2**	**2**	**1**	**1**	**2**
CO3	Make predictions of the behavior of a given physical system based on the analysis of its Mathematical Model.	**3**	**2**	**3**	**1**	**1**	**2**
CO4	Demonstrate understanding of powerful mathematical tools such as calculus of several variables, differential equations and elementary dynamical systems theory	**3**	**2**	**3**	**1**	**1**	**3**
CO5	Recognize the power of mathematical modeling and analysis and be able to apply their understanding to their further studies.	**3**	**2**	**1**	**1**	**1**	**2**
3 Strong contribution, 2 Average contribution , 1 Low contribution							

12. Brief description of self-learning / E-learning component

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

13. Books recommended:

1. J.N. Kapur: Mathematical modeling Wiley Eastern limited, 1990.
2. Principles of Mathematical Modeling, 2nd Edition, Clyve L. Dym, Elsevier Academic Press.
3. A Course in Mthematical Modeling, Douglus Munee
4. Concepts in Mathematical Modeling, Walter J Meyer

1. Name of the Department: Mathematics						
2. Course	**Linear Programming**			**L**	**T**	**P**
3. Course	**MT308**			3	1	0
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite		**6. Frequency (use tick marks)**	Even(✓)	Odd	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials						
Lectures = 30	**Tutorials = 10**	**Practical = Nil**				

8. 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.

9. COURSE OUTCOMES (CO):
After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
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.

10. Unit wise detailed content

Unit-1	**Number of lectures**	**Title of the unit:**

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

Unit-2	**Number of lectures**	**Title of the unit:**

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

Unit-3	Number of lectures	Title of the unit:

Integer programming formulation, all integers and mixed integer programming problems, Gomory's cutting plane algorithm, Branch and bound algorithm. Knapsack problem

Unit-4	Number of lectures	Title of the unit:

Stochastic programming models, Chance constraints optimization, two stage problems. Goal Programming methods and applications

Unit-5	Number of	Title of the unit:

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.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Formulation of real life problems in the form of linear programming problem and various method to solve the formulated LPP.	3	2	1	2	2	1	3
CO2	Can obtain the problem when changing the parameters of the problem in later stages.	3	1	1	1	2	1	3
CO3	Understanding pure and mixed integer programming problems with different methods of solving those problems.	3	1	1	2	2	1	3
CO4	Understand Multi-objective and Stochastic programming problem and various methods to make them deterministic in order to solve efficiently.	3	2	3	1	1	1	3
CO5	Learn decision making problems under various environments explicitly the theory of games.	3	2	1	2	2	1	3

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

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
9. https://www.youtube.com/watch?v=hibV5YbZvBw

Recommended 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