Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	CH314	**Title of the Course**	Advance Inorganic Chemistry	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**					
Course Objectives	The main objective of this course is to understand the bonding in coordination compounds, electronic spectra and magnetic behaviour of the coordination compounds and some important inorganic compounds. The other important objective is to study the reaction mechanism in coordination compounds and importance of inorganic metals in bio-inorganic chemistry.						

Course Outcomes	
CO1	Understand the concept of coordination chemistry with different theories.
CO2	Understand and evaluate the electronic spectra and magnetism of transition metal complexes.
CO3	Study of some important inorganic compounds and their applications
CO4	Understand the different reaction mechanisms in coordination compounds.
CO5	Understand the concept of Bio-inorganic chemistry and the role of metal ions in human body.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Bonding in coordination compounds	Electronic configuration (3d, 4d, 5d) and general periodic trends, comparative study of first/second/third transition series elements, IUPAC nomenclature of coordination compounds, VBT (hybridization/magnetism/geometry) of $Ni(CN)_4^{2-}$, $NI(CO)_4$, $Ni(Cl)_4^{2-}$, $Fe(CN)_6^{3-}$, $Fe(CN)_6^{4-}$. Elementary Crystal Field Theory: splitting of dn configurations in octahedral, square planar and tetrahedral fields, factioras affecting 10 Dq value, crystal field stabilization energy, pairing energy, Magnetic moment from crystal field theory, high spin and low spin complexes, Static and Dynamic Jahn-Tellar distortion.	08	01
2	Spectra and magnetism of transition metals	Spectro-chemical series of ligands, Laporte's selection rule, colour of complexes, spectroscopic ground states, selection rules for electronic spectral transitions, charge transfer spectra, LS coupling. Types of magnetism and temperature dependence of magnetic susceptibility, Curie and Curie-Weiss law, Measurement of magnetic susceptibility by Gouy method, Faraday method.	08	02
3	Selected topics in advanced inorganic compounds	Structure/synthesis/various chemical reactions of potassium dichromate, potassium permanganate, potassium chromate, sodium thiosulphate. Structure/synthesis/various chemical reactions of fluorides and oxides of xenon, Zeise's salt, silicones, borazine, phosphazine. S4N4, P4, P4O6, P4O10. Extractive metallurgy for self-reduction method (Copper and lead), cyanide process and chemical reactions (silver and gold).	08	03
4	Reaction mechanism of ligand displacement reactions	Substitution reaction in square planar complexes (Trans effect), mechanism of substitution reaction, Electron transfer reactions and its classification. Outer sphere electron transfer mechanism, chemical activation, Marcus theory, cross-reactions, thermodynamical/kinetic parameters, inner-sphere electron transfer mechanisms, effect of the nature of metal/ligandss, bridging group effects, cross reactions.	08	04
5	Bioinorganic chemistry	Biological role of inorganic metals in human body (description only), Electron transfer proteins, Metal ion transport and storage, Feritin and its structure, Oxygen transport by heme proteins, hemoglobin and myoglobin, Dioxygen transport (hemoglobin, hemocyanin and Blue copper proteins), Biomineralization (ferritin), zinc finger protein, Carbonic anhydrase, carboxy peptidase, carboxypeptidase A/B.	08	05

Reference Books:

Inorganic Chemistry: Structure and Reactivity, James E. Huheey, Harper and Row Publishers, New York

Advanced Inorganic Chemistry: F.A. Cotton and G. Wilkinson, Interscience.

Inorganic Reaction Mechanism, Basolo and R.G. Pearson, John Willey.

e-Learning Source:

https://nptel.ac.in/courses/104/105/104105033/

https://ocw.mit.edu/courses/chemistry/5-112-principles-of-chemical-science-fall-2005/video-lectures/lecture-32-coordination-complexes-and-ligands/

https://www.chem.tamu.edu/rgroup/marcetta/chem362/lectures/Lecture%2029%20subset%20of%20TM%20lecture%20notes.pdf

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

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

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

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	CH315	**Title of the Course**	Advance Organic Chemistry	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**					
Course Objectives	The main objective of this course is to study the nomenclature of organic compounds, structure and bonding of organic molecules considering inductive effect, hyperconjugation, mesomeric effects, hydrogen bonding etc., and mechanism of various types of organic reactions.						

Course Outcomes	
CO1	Analyze structure and chemical reactions of organomagnesium and organolithium compounds.
CO2	Understand and evaluate the structure and related reactions of heterocyclic compounds.
CO3	Understand and analyze the classification, configuration and conformation of carbohydrates.
CO4	Understand and evaluate the structure of amino acids, peptides, proteins and nucleic acids..
CO5	Understand and analyze the structure and classification of dyes.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Organometallic and organosulphur compounds	Organomagnesium Compounds: the Grignard reagents, structure and chemical reactions Organolithium Compounds: formation and chemical reactions. Nomenclature, methods of formation and chemical reaction of thiols, sulphonic acids.	08	01
2	Heterocyclic compounds	Molecular orbital picture and aromatic charecteristics of pyrrole, furan, thiophene and pyridine. Comparison of basicity of pyridine, piperidine and pyrrole. Methods of synthesis and chemical reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis.	08	02
3	Carbohydrates	Carbohydrates: classification and configuration and conformation of monosaccharides, Erythro and threodiastereomers, mechanism of osazone formation, Interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Formation of glycosides, ether and esters. Cyclic structure of D(+) glucose. An introduction to disaccharides (maltose, sucrose, lactose) and polysaccharides/starch and cellulose.	08	03
4	Acids, peptides, proteins and nucleic acids	Classification, structure and stereochemistry of amino acids, isoelectric point. Classification of protiens, peptides, structure determination, and end group analysis. Nucleic acids: Introduction –Classification of Nucleic Acids Ribonucleosides and Ribonucleotides. The double helical structure of DNA.	08	04
5	Dyes	Dyes: Introduction of the history of dyes. Landmarks in the historical development from Natural to synthetic dyes. Introduction and classification of dyes on the basis of structure Colour and chemical constitution of dyes. Structure and uses of phenolphthalein, fluorescein , Eosin, Malachite green, Methylene blue , Indigo. Napthol yellow- S, Crystal violet.	08	05

Reference Books:

Advanced Organic Chemistry, Bahl&Bahl, S. Chand & Co. Ltd.

Organic Chemistry Vol.I& II, I.L. Finar

Fundamentals of Organic Chemistry, NafisHaider, S. Chand & Co. Ltd.

A text book of Organic Chemistry, Bahl&Bahl, S. Chand & Co. Ltd.

Organic Chemistry Vol.I, II & III, Dr. Jagdamba Singh, L.D.S. Yadav, Pragati Prakashan.

e-Learning Source:

https://www.khanacademy.org/science/organic-chemistry

https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_(Smith)/Chapter_06%3A_UnderstandingOrganic_Reactions

https://www.dummies.com/education/science/biology/the-basics-of-organic-chemistry/

https://www.toppr.com/guides/chemistry/organic-chemistry/

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

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

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

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	CH319	**Title of the Course**	Basics of Chromatographic Techniques	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**2**	**1**	**0**	**3**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**					
Course Objectives	To develop understanding of Separation techniques such as Thin layer chromatography, Paper chromatography, Gas chromatography, High performance Liquid Chromatography and Ion exchange chromatography.						

Course Outcomes	
CO1	Understand the chromatographic techniques and its classification.
CO2	Evaluate Thin layer chromatography; principle and its applications. Paper chromatography and its applications. Separation of amino acid mixture.
CO3	Comprehension of Principles of gas-liquid chromatography, Instrumentation and its Industrial applications.
CO4	Able to discuss Normal and reverse phase HPLC, Isocratic and gradient elution, Instrumentation; mobile phase reservoir, column and detector and Industrial applications of HPLC.
CO5	Analyze the action of resins, experimental techniques, applications, separation of metal ions, separation of chloride and Bromide ions -removal of interfering radicals.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Separation techniques	Chromatography, Classification of Chromatographic methods, Elution in column chromatography, chromatograms, distribution constant, retention time, stationary phase, mobile phase, principle of adsorption and partition chromatography, column chromatography; principle, adsorbents used, preparation of column, adsorption, elution.	07	01
2	Thin layer chromatography	Principle, choice of adsorbent and solvent, Rf value, applications. Paper chromatography; solvents used, principle, Rf value, factors influencing Rf value, applications. Separation of amino acid mixture.	07	02
3	Gas chromatography	Introduction, Principles of gas-liquid chromatography, Instrumentation; Carrier gas system, Sample injection, Columns, Stationary phase, Detectors (Flame Ionization, Electron capture and Thermal conductivity) and Industrial applications.	07	03
4	High performance liquid chromatography	Introduction of HPLC, Normal and reverse phase HPLC, Isocratic and gradient elution, Instrumentation; mobile phase reservoir, column and detector (UV-visible absorption, Electrochemical) and Industrial applications of HPLC.	07	04
5	Ion exchange chromatography	Principle, resins, action of resins, experimental techniques, applications, separation of metal ions, separation of chloride and Bromide ions - removal of interfering radicals.	07	05

Reference Books:

Fundamentals of Analytical chemistry, Douglas A. Skoog, Donald M. West, F. James Holler, 7th edition, Harcourt college publications.

Principles and practice of analytical chemistry, F. W. Fifield, D. Kealey, 5th edition, Blackwell publication.

Analytical chemistry, Gary D. Christian, 6th edition, Wiley and sons publication.

Basic concepts of analytical chemistry, S. M. Kopper, New Age International Publishers. Analytical chemistry, D. Kealey, P.J.Haines, Viva books Pvt.

Analytical chemistry- Instrumental Techniques (Vol. II) – Mahindu Singh, Dominant publishers. Ltd

e-Learning Source:

https://microbenotes.com/chromatography-principle-types-and-applications/

https://www.khanacademy.org/science/class-11-chemistry-india/xfbb6cb8fc2bd00c8:in-in-organic-chemistry-some-basic-principles-and techniques/xfbb6cb8fc2bd00c8:in-in-methods-of-purification-of-organic-compounds/v/basics-of-chromatography

https://www.slideshare.net/nadeemakhter7374/chromatography-34247423

http://www.biologydiscussion.com/biochemistry/chromatography-techniques/top-12-types-of-chromatographic-techniques-biochemistry/12730

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

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

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

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	CH316	**Title of the Course**	Chemistry Practical-V	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**					
Course Objectives	Student will be able to work effectively and safely in a laboratory environment, practical/technical/ communication skills, concepts to solve qualitative and quantitative problems,transferable skills like ability to work in teams as well as independently.						

Course Outcomes	
CO1	To acquire knowledge of the synthesis and analysis of cis- and trans-bisoxalatodiaqua chromate, potassium trioxalatoferrate (III), and potassium trioxalatoferrate (III).
CO2	Understand how to determine concentration and quantify Fe^{3+} content using the Beer-Lambert rule.
CO3	To develop the capability to differentiate natural goods from dyes with the help of chromatography.
CO4	To develop the ability to find racemic mixtures and synthesise methyl orange and methyl red.
CO5	To use oxidation and reduction processes to conduct the synthesis of organic molecules.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Experiment-01	Synthesis and Analysis of the Potassium trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$ and determination of its composition by permagnometry. (a) Potassium trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$ and determination of its composition by permagnometry.	4	1
2	Experiment-02	Preparation of cis-and trans –bisoxalatodiaqua chromate (III) ion.	4	1
3	Experiment-03	To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given solution	4	2
4	Experiment-04	Determination of Fe^{3+} content by thiocyanate method.	4	2
5	Experiment-05	Separation of Fluorescein and methylene blue by column chromatography.	4	3
6	Experiment-06	Separation of leaf pigments from leaves	4	3
7	Experiment-07	Resolution of racemic mixture of (+) mandelic acid	4	4
8	Experiment-08	Diazotization/coupling: Preparation of methyl orange and methyl red	4	4
9	Experiment-09	Oxidation: Preparation of benzoic acid from toluence	4	5
10	Experiment-10	Reduction: Preparation of aniline from nitrobenzene	4	5

Reference Books:

CRC Handbook of Chemistry and Physics: 97th ed.

McGraw-Hill Concise Encyclopedia of Chemistry by McGraw-Hill Education Staff.

A Dictionary of Chemistry by Jonathan Law (Editor); Richard Rennie.

Encyclopedia of Chemistry by Don Rittner; Ronald A.

e-Learning Source:

https://www.fandm.edu/uploads/files/79645701812579729-genchem-reference-for-web.pdf

http://file.akfarmahadhika.ac.id/E-BOOK/12-1213-akfarmahad-16-1-vogelqu-d.pdf

https://faculty.psau.edu.sa/filedownload/doc-6-pdf-f06110ef2e1e1ae119cbacf71dd17732-original.pdf

https://www.stem.org.uk/resources/collection/3959/practical-chemistry

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

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

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

Integral University, Lucknow

Effective from Session: 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	2
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	3
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	2

Reference Books:

G. B. Thomas, M.D. Wier, J. Hass: Calculus, Pearsons Education

S. C . Malik and S. Arora : Mathematical analysis, Wiley Eastern Ltd; D. V. Widder: Advanced Calculus, Prentice Hall of India Pvt. Ltd.

e-Learning Source:

https://nptel.ac.in/courses/111107108/

file:///C:/Users/Admin/Downloads/Vector%20Calculus%20by%20Krishna%20Series.pdf

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	PSO4	PSO5
CO1	3	2	2	1	1	1	2	2	2	2	3
CO2	3	2	2	1	1	1	2	1	1	2	2
CO3	3	2	2	1	1	1	2	2	2	2	2
CO4	3	1	2	1	1	1	2	2	2	3	2
CO5	3	1	2	1	1	1	2	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: 2018-19							
Course Code	MT302	**Title of the Course**	**Mathematical Statistics**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**2**	**1**	**0**	**3**
Pre-Requisite	10+2 with Mathematics	**Co-requisite**					
Course Objectives	The course explores the basic concepts of modern statistics and its applications for decision-making in economics, business, and other fields of sciences. Our everyday lives, as well as economic and business activities, are full of data analysis and distribution theory offer useful techniques for quantifying these uncertainties. The course is heavily oriented towards the formulation of mathematical statistics and practical applications.						

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

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

Reference Books:

Sampling techniques: W.G. Cochran, Wiley

Sampling methodologies and applications: P.S.R.S. Rao, Chapman and Hall/CRC 2000

Elements of sampling theory and methods: Z. Govindrajalu, Prentice Hall, 1999

Sampling: P. Mukhopadhyaya, Prentice Hall of India, 1998.

Theory of sample surveys with applications: P.V.Sukhatme, B.V.Sukhatme, S. Sukhatme and C. Asok, IASRI, Delhi, 1984.

Sampling Techniques: Daroga Singh & Chaudhry, F.S New age International

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	PSO4	PSO5
CO1	2	2	3	2	2	2	2	1	1	2	2
CO2	3	3	2	2	2	3	2	2	2	2	3
CO3	2	2	3	3	2	2	2	2	2	2	3
CO4	2	2	2	3	2	2	1	1	2	2	2
CO5	2	3	2	3	2	2	3	2	2	2	3

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

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

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	MT303	**Title of the Course**	Number Theory	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**2**	**1**	**0**	**3**
Pre-Requisite	10+2 with PCM	**Co-requisite**					
Course Objectives	The course is intended to allow students to be exposed to some foundational ideas in number theory without the technical baggage often associated with a more advanced courses. The course provides students an opportunity to develop an appreciation of pure mathematics while engaged in the study of number theoretic results. The course is also designed to provide students an opportunity to work with conjectures, proofs, and analysing mathematics.						

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

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Cartesian product of sets, Equivalence relation and partition, Fundamental theorem of equivalence of relation, Equivalence sets.	8	1
2		Cardinal numbers, power of continuum, cardinal arithmetic, Inequalities in cardinals, Cantor's theorem, Schrodar Berntien Theorem	6	1
3		Division Algorithm, greatest common divisor, least common multiplier, prime number, unique factorisation theorem.	6	2
4		Congruence, Complete residue theorem, Euler's theorem	6	2
5		Linear congruence, Chinese remainder theorem, problem based on Chinese remainder theorem, Lagrange's theorem	6	2

Reference Books:

J Hunter: Number Theory

David M. Burton: Elementary Number Theory

Seymour Lipschutz: Set theory and related topics

e-Learning Source:

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

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	PSO4	PSO5
CO1	3	1	1	1	2	3	3	1	1	2	2
CO2	3	2	1	1	2	1	3	-	-	-	-
CO3	2	2	1	1	2	1	3	-	-	-	-
CO4	3	2	2	1	1	1	1	-	-	-	-
CO5	3	2	1	1	2	1	3	-	-	-	-

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

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

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	MT304	**Title of the Course**	Statistical Techniques Lab	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Mathematics	**Co-requisite**					
Course Objectives	To make students capable of describing data in practical situations simultaneously to teach students to make proper and efficient use of the tools which are used to describe data. To make students able to fit real time data on various pre-defined probability distributions.						

Course Outcomes	
CO1	After completing Practical 1, students will be able to create visual representation of various types of data.
CO2	After the completion of Practical 2, 3 and 4, students will be able to well describe the central value and variability of data. Students will also learn the method of comparison of variability between to or more data sets and to figure out the shape of the given data in terms of skewness and Kurtosis.
CO3	After the completion of Practical 5, 6 & 7 students will be able to obtain the degree of relationship between two or more variables for qualitative and quantitative data both. Students will also be able to find out functional relationship between two or more variables.
CO4	After the successful completion of Practical 8, students will be able to fit real data on a given Binomial distribution.
CO5	After the successful completion of Practical 9, students will be able to fit real data on a given Poisson distribution.
CO6	After the successful completion of Practical 10, students will be able to fit real data on Normal distribution for given mean and variance.

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

Reference Books:

Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

e-Learning Source:

https://youtu.be/KIBZUk39ncI

https://www.youtube.com/watch?v=m9a6rg0tNSM

https://www.youtube.com/watch?v=nqPS29IvnHk

https://www.youtube.com/watch?v=JPK0LFsu18g

https://www.youtube.com/watch?v=vvv9DhUrzlY

https://www.youtube.com/watch?v=uq5w2aFwNhE&list=PLLgJVrtHe9RoB9LIZPuwv_zZNmGniGrai

https://www.youtube.com/watch?v=5lh1Wr5_1Q0&list=PLGihLBEp_66K6zl4QGMXIf-d1hcoXIQ0a

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO4	PSO5
CO1	3	1	2	1	1	1	3	2	2	1	2
CO2	3	1	2	1	2	1	3	3	3	2	2
CO3	3	2	1	1	2	1	2	2	2	2	3
CO4	2	1	1	1	2	1	3	2	2	3	3
CO5	2	2	1	2	2	1	3	2	2	2	3
CO6	2	1	1	1	2	1	3	2	2	2	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	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	1
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	2
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	3
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	4
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	5

Reference Books:

A. Beiser, "Perspectives of Modern Physics (McGraw Hill).

H. E. White; "Introduction to Atomic Physics (D. Van Nostrand Company)

R. P. Feymann, R. B. Leighton and M. Sands; "The Feynman Lectures on Physics, Vol. III (B I Publications. Bombay. Delhi, Calcutta, Madras).

Eisenberg and Resnick; "Quantum Physics of Atoms, 'Molecules, Solids, Nuclei and Particles" (John Wiley).

e-Learning Source:

https://nptel.ac.in/courses/115/104/115104096/

https://nptel.ac.in/courses/115/102/115102023/

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	PSO5
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: 2018-19							
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	1
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	2
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	3
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	4
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	5

Reference Books:

A. Beiser, "Concepts of Modern Physics" (McGraw-Hill).

B. B. Laud, "Introduction to Statistical Mechanics" (Macmillan 1981).

F. Reif, "Statistical Physics" (McGraw-Hill 1988).

K. Haung, "Statistical Physics" (Wiley Eastern, 1988).

e-Learning Source:

https://nptel.ac.in/courses/115/106/115106123/

https://nptel.ac.in/courses/115/105/115105098/

https://nptel.ac.in/courses/115/101/115101011/

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	PSO5
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: 2018-19							
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	1
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	2
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	3
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	4
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	5

Reference Books:

Puri and Babbar, "Solid State Physics" (S. Chand).

C. Kittel, "Introduction to Solid State Physics"- Vth Edition (John Wiley & Sons).

H. S. Mani and G. K. Mehta, "Introduction to Modern Physics" (Affiliated East-West Press— 1989).

A. Beiser, "Perspectives of Modern Physics" (McGraw-Hill).

Martin, B.R. and Shaw, Particle Physics (John Wiley).

e-Learning Source:

https://nptel.ac.in/courses/115/104/115104109/

https://nptel.ac.in/courses/115/105/115105099/

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	PSO5
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	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.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Exp-01	To study the charging and discharging of RC and LCR circuits.	2	1
2	Exp-02	To study of Lissajous figures using a CRO.	2	1
3	Exp-03	To study the spectral response of a solar cell.	2	2
4	Exp-04	To calibrate a ballistic galvanometer with a standard solenoid and then to find out ballistic constant.	2	3
5	Exp-05	Hall Probe Method for measurement of magnetic Field.	2	3
6	Exp-06	Study of decay of currents in LR and RC circuits.	2	4
7	Exp-07	To study the response curve for LCR circuit and hence estimate the resonance frequency and quality factor.	2	4
8	Exp-08	To determine the capacitance of a condenser by Wien's bridge.	2	5
9	Exp-09	To draw the characteristic of a photoelectric cell.	2	2
10	Exp-10	To study Time constant in a LR circuit.	2	4

Reference Books:

Practical Physics. by R. K. Shukla, New Age International Private Limited; Third edition.

B.Sc. Practical Physics by Harnam Singh and Hemme, S. Chand.

B. Sc. Practical Physics by CL Arora, S Chand & Company.

Practical Physics by Kumar P.R.S., Prentice Hall India Learning Private Limited

e-Learning Source:

https://www.exploratorium.edu/snacks/subject/electricity-and-magnetism

https://ocw.mit.edu/courses/physics/8-02-physics-ii-electricity-and-magnetism-spring-2007/experiments/

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	PS04	PS05
CO1	3	2	1	-	3	1	2	1	-	1	3	-
CO2	2	1	3	-	2	2	3	2	-	1	3	-
CO3	3	2	2	-	3	3	2	3	-	2	3	-
CO4	2	3	3	-	1	2	3	3	-	3	3	-
CO5	3	2	1	-	3	1	2	2	-	1	3	-

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

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

Integral University, Lucknow

Effective From Session: 2018-19							
Course Code	CH308	**Title of the Course**	Spectroscopic Techniques	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**					
Course Objectives	Students able to understand the interaction of electromagnetic radiation with the materials, spectroscopic techniques like Ultraviolet, FT-IR, Nuclear Magnetic Resonance spectroscopy and mass spectrometry.						

Course Outcomes	
CO1	Understanding Wave-like propagation of light, electronic transitions, instrumentation, conjugated systems and transition energies, Woodward – Fieser rules for calculation of wave length.
CO2	Comprehension of absorption in the infrared region, theory of infrared spectroscopy, instrumentation, molecular vibrations, factors affecting vibrational frequencies, characteristic absorptions in common classes of compounds.
CO3	To create basics of NMR spectroscopy, instrumentation, chemical shift, equivalent and nonequivalent protons, spin-spin splitting and vicinal coupling.
CO4	Able to evaluate the NMR spectra of some representative compounds: Hydrocarbons, Aldehydes, Ketones, Acids and Alcohols, Applications of NMR spectroscopy.
CO5	Analyze the theory, instrumentation, important useful terms in mass spectrometry and atomic absorption spectrophotometry; molecular ion peak, metastable peak, fragmentation patterns of various functional groups (alkanes, alkenes, alkynes, alcohols, ketones, aldehydes), Mclafferty rearrangements.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	UV spectroscopy	Wave-like propagation of light, absorption of electromagnetic radiation by organic molecules allowed and forbidden transitions, instrumentation, conjugated systems and transition energies, Woodward – Fieser rules; unsaturated carbonyl compounds, conjugated dienes and polyenes.	08	01
2	IR spectroscopy	Introduction, absorption in the infrared region, theory of infrared spectroscopy, instrumentation, molecular vibrations, factors affecting vibrational frequencies, characteristic absorptions in common classes of compounds, characteristic vibrational frequencies of some organic compounds.	08	02
3	NMR spectroscopy	Introduction, theory of NMR spectroscopy, instrumentation, chemical shift, equivalent and nonequivalent protons, spin-spin splitting, vicinal coupling,, Interpretation of NMR spectra of some representative compounds.	08	03
4	Mass spectroscopy	Introduction, basic theory, instrumentation, important useful terms in mass spectrometry, fragmentation patterns of various functional groups (alkanes, alkenes, alkynes, alcohols, ether, phenols and amines, ketones, aldehydes, esters, acids, anhydrides), molecular ion peak, metastable peak, Mclafferty rearrangements, Nitrogen rule.	08	04
5	Atomic absorption spectrophotometry	Introduction, Principle, Instrumentation, Sample preparation, Internal standard and standard addition, calibration and applications of AAS.	08	05

Reference Books:

Introduction to spectroscopy: Pavia, Lampman & Kriz, 3rd Ed, Books/cole.

Spectroscopic methods in organic chemistry: H. Williams and Ian fleminig, V Edition Tata Mc Grawhills

Organic spectroscopy: William Kemp, 3rd Edition, Palgrave publications.

Fundamentals of Analytical chemistry, Douglas A. Skoog, Donald M. West, F. James Holler, 7th edition, Harcourt college publications.

Principles and practice of analytical chemistry, F. W. Fifield, D. Kealey, 5th edition, Blackwell publication.

Analytical chemistry, Gary D. Christian, 6th edition, Wiley and sons publication.

Basic concepts of analytical chemistry, S. M. Kopper, New Age International Publishers.

e-Learning Source:

https://www.youtube.com/watch?v=2Y8pSoS0d1g

http://www.infocobuild.com/education/audio-video-courses/chemistry/ApplicationOfSpectroscopicMethods-IIT-Madras/lecture-25.html

https://scrippslabs.com/summary-of-spectroscopic-techniques/

https://nptel.ac.in/content/storage2/courses/102103044/pdf/mod2.pdf

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

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

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

Integral University, Lucknow

Effective From Session: 2018-19							
Course Code	CH309	**Title of the Course**	Chemical Process Industry	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**	-				
Course Objectives	The main objective of this course is to study the composition, preparation, properties and uses of ammonia, nitric acid, phosphorus chemical, glass, cement, ceramics and refractories and their related toxic hazards on the health of consumer.						

Course Outcomes	
CO1	Evaluate different preparation processes for the manufacture of ammonia, nitric acid, ammonium nitrate and ammonium sulphate and their related quality control, hazards, safety and effluent management.
CO2	Evaluate different manufacturing methods of caustic soda and phosphorus chemicals and their properties and uses.
CO3	Understand the composition of glass and their types, properties and uses.
CO4	Analyze the composition, types, properties and preparation of cement and its setting time.
CO5	Understand the classification, properties and uses of ceramics and refractories and their respective characteristics.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Synthetic nitrogen products	Ammonia, nitric acid, ammonium nitrate and ammonium sulphate their manufacture with reference to; consumption Pattern, Raw materials, Production process, Quality control, Hazards and safety and Effluent management.	08	01
2	Chloro – alkali industrial products	Caustic soda Chlorine. Phosphorus chemicals; Phosphorus, phosphoric acid, ammonium phosphate, superphosphate, triple superphosphate. Lime, gypsum, Silicon, calcium carbide.	08	02
3	Glass	Introduction, Classification and General Properties of Glass , Characteristics, raw Materials, Chemical Reactions, Methods of Manufacture and Uses.	08	03
4	Cement	Introduction, Composition, Types of cement, Portland cement; raw Materials, manufacture of Cement by wet & Dry process, Reaction in the Kiln, setting of cement, Testing & Uses of cement.	08	04
5	Ceramics and refractories	Introduction, Types of ceramics materials, properties and applications. Refractories, classification of refractories, characteristics of refractories materials, properties of refractories. Neutral refractories; Silicon carbide. Acid refractories; High Alumina refractories.	08	05

Reference Books:

Shreve R.N. Brink. J.A., Chemical Process Industries, International student edition, Pubs: McGraw Hill Book Co. New York, 1960.

Groggins P.M., Unit Process in Organic Synthesis, 5th edition, International student edition, Pubs: McGraw-Hill Book Co., New York, 1998.

Dryden's outlines of Chemical Technology, edited and revised by Gopala Rao M. and Marshall S, Pubs: East-West Press, New Delhi, 2004.

Industrial Chemistry B.K.Sharma, goel publishing house.

Chemical process industries N.R Nerris shreve.

Chemical process principales: part 1 & II – O.A / Hougen, K.M Watson RA Ragatz (CBS)

e-Learning Source:

https://encyclopedia2.thefreedictionary.com/chemical+process+industry

https://www.youtube.com/watch?v=RjZJjneJ5fk

https://www.chemicalprocessing.com/

https://www.britannica.com/science/phosphorus-chemical-element

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	PSO6	PSO7
CO1	3	2	3	2	2	3	2	3	2	-	1	1	-	-
CO2	3	2	3	2	1	3	2	3	2	-	1	1	-	-
CO3	3	2	3	2	1	3	2	3	2	-	2	1	-	-
CO4	3	2	3	2	1	3	2	3	2	-	1	1	-	-
CO5	3	2	3	2	1	3	2	2	2	-	1	1	-	-

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

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

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	CH317	**Title of the Course**	Chemistry of Polymers	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**					
Course Objectives	The main objective of this course is to study the mechanism of polymer preparation, their processing techniques, commercial uses, identification techniques and preparation process of vinyl polymers, polyamides, polyesters, synthetic rubbers, cellulose and copolymer resins.						

Course Outcomes	
CO1	Student will be able to evaluate the different mechanisms of polymer preparation and their classification.
CO2	Student will be able explain various polymer reactions such as hydrolysis, acidolysis, crosslinking etc.
CO3	Understand the colligative properties of Polymers and evaluate the identification techniques such as NMR and FTIR of Polymers.
CO4	Understand the degradation and its types.
CO5	Understand the preparation process of vinyl polymers, polyamide, polyesters and rubbers.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Polymer introduction	Basic concepts of polymer science, Classification of polymers, Average molecular weight and Molecular weight distribution. Polymerization: Mechanism and kinetics of: Free radical addition polymerization, Ionic addition polymerization, Coordination polymerization, Step growth polymerization.	08	01
2	Polymer reactions	Introduction; types- hydrolysis, acidolysis, addition, substitution, halogenation, hydrogenation, crosslinking, curing, (brief mechanism and usefulness of each reaction to be highlighted with examples).	08	02
3	Structure and properties	Thermal transitions, Crystallinity, Molecular weight characterization, Nuclear Magnetic Resonance (NMR) and Fourier Transform Infrared (FTIR) techniques.	08	03
4	Polymer degradation	Introduction, Types of degradation- thermal degradation, mechanical degradation, degradation by ultrasonic waves, photo degradation, degradation by high-energy radiation, oxidative degradation and hydrolytic degradation and biodegradation.	08	04
5	Synthesis, properties and applications	Polystyrene, Polyacrylonitrile, Polymethacrylate, Polymethylmethacrylate, Polyethene, Polybutadiene, Polyvinylidene, Polycarbonates, Polyesters, Polyurethanes, Phenolic polyesters, Polyamides, Polysulphones.	08	05

Reference Books:

Principles of polymer chemistry: A Ravve, 2nd Edition, Kluwer Academic publications

Polymer Science and technology: Joll. R. Fried, Prentice – Hall.

Principles of polymer systems: F. Rodriguez, Claude Cohen, C.K. Ober, L.A. Archer, Vth Edition, Taylor & Francis

Introduction to polymers: R.J. Young and P.A. Lovell, 2nd Edition, Netron Thornes publications

Polymer chemistry – an introduction, Malcolm D. Stevens, Oxford University press.

e-Learning Source:

https://www.youtube.com/watch?v=kMHYNuyKQ2Q&list=PLBAcrca02tZdHmbDFvnOA6ZYTJPnF5sMe

https://www.youtube.com/watch?v=Gzin6mP-tUM&list=PLLy_2iUCG87CbDZMn4eP_XT09XTJOVooJ

https://www.youtube.com/watch?v=68fF7Tnl0wE

https://www.youtube.com/watch?v=YZf5q-ICf8Y

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	-	-	-	-	3	3	3	3	3	3	3
CO2	3	-	-	-	-	3	3	3	3	3	3	3
CO3	3	-	1	-	-	3	3	3	3	3	3	3
CO4	3	-	1	-	-	3	3	3	3	3	3	3
CO5	3	-	1	-	-	3	3	3	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: 2018-19							
Course Code	CH310	**Title of the Course**	Fundamental Of Food Chemistry	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**	-				
Course Objectives	The course focuses on providing knowledge of food constituents, food additives and food processing techniques. The study of food laws and standards appraise students about quality and safety assurance and food related hazards.						

Course Outcomes	
CO1	Understanding of Indian food law and food standards, value of quality assurance and safety assurance
CO2	Comprehension of chemical structure, properties and argue importance of food components, including carbohydrates, protein, lipids, vitamins and minerals.
CO3	Describe the principles in food processing techniques and differentiate food preservation methods like heat preservation and cold preservation, food packaging
CO4	Able to explain different types of food additives with examples and judge its value in real life.
CO5	Analyze the importance of food safety and food related physical, chemical and biological hazards.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Governmental regulations	Introduction, Food laws and standards: Indian food safety laws and standards; Quality and safety assurance in food industry; BIS Laboratory Services and Certification by BIS.	8	1
2	Constituents of food and their nutritive aspects	Carbohydrates, Proteins, Fats and oils, Vitamins and Minerals.	8	2
3	Food processing techniques	Common unit operations, Food deterioration and their control; Heat preservation and processing, Cold preservation and processing Food dehydration, Food concentration & food packaging.	8	3
4	Food additives	Preservatives, Antioxidants, Chelating agents, Surface active agents, Stabilizing and Thickening agents, Buffering agents, Colouring agents, Sweetening agents & Flavoring agents.	8	4
5	Food safety, risks and hazards	Food related Hazards, Microbiological Considerations in food safety, Effects of processing and storage on microbial safety, Chemical hazards associated with foods, Prevention methods from food born disease.	8	5

Reference Books:

Food Chemistry, Belitz and Gosch, Springer – Verlag Bertin Heiderberg, 2nd Edition, 1999

Principles of Human Nutrition, Martin Eastwood, Chapman and Hall, London, I Edition, 1997.

Food – The Chemistry of its Components, T.P. Coultate, Royal Soc. Chemistry, 4th Edition, 2002.

Food additives, Branan, Alfred Larry, Davidson P. Michae, Food Science and Technology series (35), Morcel Dekker, Inc, 1990.

Introduction to food science, Rick Parker, Delmar Learning, U.S.A, I Edition, 2003.

Nutrition Science and application, Lori Smolin L.A., Saunders College Publishing, 3rd Edition.

e-Learning Source:

http://www.basicknowledge101.com/pdf/Food%20chemistry.pdf

https://courses.foodcrumbles.com/courses/food-chemistry-basics/

https://www.cabdirect.org/cabdirect/abstract/19710406009

https://byjus.com/chemistry/food-chemistry/

	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	3	-	1	1	3	3	3	3	-	3	-
CO2	3	2	-	2	1	2	2	3	2	-	2	-
CO3	3	3	-	1	1	3	2	3	3	-	3	-
CO4	3	3	-	1	1	3	3	3	3	-	3	-
CO5	3	2	-	2	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: 2018-19							
Course Code	CH318	**Title of the Course**	UG Chemistry Project	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**0**	**0**	**8**	**4**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**					
Course Objectives	The main objective is to enhance the technical skills and to provide students industrial exposure.						

Course Outcomes	
CO1	Hands on training
CO2	Integrate class room theory with laboratory scale practice.
CO3	Understanding professional ethics of industry and code of conduct.
CO4	Increase the students' knowledge and understanding of chemical science
CO5	Ensure that students receive essential training in laboratory safety procedures

	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	3	3	3	3	3	3	3
CO2	3	-	-	-	2	3	3	3	3	3	3	3
CO3	3	-	-	-	1	3	3	3	3	3	3	3
CO4	3	-	-	-	1	3	3	3	3	3	3	3
CO5	3	1	-	-	3	3	3	3	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: 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 especially 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 types 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	2
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	3
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	3

Reference Books:

Robert G. Bartle and Donald R. Sherbert : Introduction to Real Analysis,Wiley Student Edition.

S. C . Malik and S. Arora : Mathematical analysis, Wiley Eastern Ltd.

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:

https://www.youtube.com/watch?v=-uCwgZUz51o

https://nptel.ac.in/courses/111107113/

https://study.com/academy/lesson/types-of-mathematical-models.html

https://www.frontiersin.org/articles/10.3389/fgene.2015.00354/fullpdf

https://www.youtube.com/watch?v=jV4Hlh8gHLs

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

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

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

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	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 methods 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 environments 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	6	2
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.	6	2
3		Integer programming formulation, all integers and mixed integer programming problems, Gomory's cutting plane algorithm, Branch and bound algorithm. Knapsack problem.	6	3
4		tochastic programming models, Chance constraints optimization, two stage problems. Goal Programming methods and applications.	6	3
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.	6	3

Reference Books:

Mokhtar S. Bazara, John J. Jarvis "Linear Programming and Network Flows" Fourth Edition. WILEY A John Wiley & Sons, Inc., Publication.

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.

David K. J. Mtetwa, "Linear Programming" Paradise publishers, US.

e-Learning Source:

https://www.youtube.com/watch?v=TwAvQJAM9Hk

https://www.youtube.com/watch?v=M8POtpPtQZc

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

https://www.youtube.com/watch?v=o-N0jFUpdWo

https://www.youtube.com/watch?v=56-iiZEjqnU

https://www.youtube.com/watch?v=LAC212ZwBB4

https://www.youtube.com/watch?v=gkm6WljmbOk

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

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

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO4	PSO5
CO1	3	2	1	2	2	1	3	1	1	1	2
CO2	3	1	1	1	2	1	3	2	2	3	2
CO3	3	1	1	2	2	1	3	2	2	2	2
CO4	3	2	3	1	1	1	3	2	1	1	2
CO5	3	2	1	2	2	1	3	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	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	2
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	1
4		Common catenary, Centre of gravity, Stable and unstable equilibrium, Virtual work.	8	3
5		Forces in three dimensions, Poinsot's central axis, Wrenches, Null line and null plane.	8	3

Reference Books:

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

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

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

M.A. Pathan: Statics

Jhonson and Beer: Vector Mechanics for Engineers

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	PSO4	PSO5
CO1	3	2	2	1	1	1	2	2	2	1	2
CO2	3	2	2	1	1	1	2	3	3	2	2
CO3	3	2	2	1	1	1	2	2	2	2	3
CO4	3	2	2	1	1	1	2	2	2	3	3
CO5	3	2	2	1	1	1	2	2	2	3	3

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

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

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	MT306	**Title of the Course**	Analysis	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Mathematics	**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 point wise 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	2
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 irichlet'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	3
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	3

Reference Books:

Robert G. Bartle and Donald R. Sherbert : Introduction to Real Analysis,Wiley Student Edition.

S. C . Malik and S. Arora : Mathematical analysis, Wiley Eastern Ltd.

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:

https://swayam.gov.in/nd1_noc20_ma03/preview

https://www.youtube.com/watch?v=gJ1pYz1k0qM

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	PSO4	PSO5
CO1	**3**	**1**	**1**	-	**2**	**1**	**1**	1	1	2	2
CO2	**3**	**1**	**2**	-	**3**	**1**	**1**	2	2	1	2
CO3	**3**	**1**	**2**	-	**3**	**1**	**1**	1	2	1	2
CO4	**3**	**1**	**1**	-	**2**	**1**	**1**	2	2	2	3
CO5	**3**	**1**	**1**	-	**2**	**1**	**1**	2	2	3	3

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

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

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	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	1
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	2
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	3
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	4
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	5

Reference Books:

B. G. Streetman; "Solid State Electronic Devices", UK Edition (Prentice-Hall of India. New Delhi, 1986).

W. D. Stanley; "Electronic Devices, Circuits and Applications" (Prentice-Hall, New Jersey, USA. 1988).

J. D. Ryder; "Electronics Fundamentals and Applications" IInd Edition (Prentice-Hall of India. New Delhi, 1986).

I. Millman and A. Grabel; "Microelectronics", International. Edition (McGraw-Hill Book Company, New York, 1988).

e-Learning Source:

https://nptel.ac.in/courses/117/107/117107095/

https://nptel.ac.in/courses/108/101/108101091/

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	PSO5
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: 2018-19							
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	1
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	2
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	3
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	4
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	5

Reference Books:

Mathematical Methods for Physicists: G. Arfken and H. J. Weber (Academic Press, San Diego) 7th edition, 2012.

Mathematical Methods in the Physical Sciences, M.L. Boas (Wiley) 2002.

Applied Mathematics for Engineers and Physicists, L. A. Pipes & L. R. Harvill (McGraw- Hill), 1971.

Mathematical Methods for Physics and Engineering, K. F. Riley, M.P. Hobson and S.J. Bence (Cambridge University Press), 1998.

e-Learning Source:

https://www.freebookcentre.net/Physics/Mathematical-Physics-Books.html

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	PSO5
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: 2018-19							
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	1
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	2
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	3
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	4
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	5

Reference Books:

Introduction to Solid State Physics by Charles Kittel (Willey Publication).

Elements of Solid-State Physics by Puri and Babbar (S. Chand).

Solid State Physics by S. O. Pillai (New Age International).

e-Learning Source:

https://nptel.ac.in/courses/115/104/115104109/

https://nptel.ac.in/courses/115/105/115105099/

https://nptel.ac.in/courses/113/107/113107075/

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	PSO5
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	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

Unit No.	Title of the Unit	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	1
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	2
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	3
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	4
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	5

Reference Books:

Introduction to Solid State Physics: C. Kittel (Wiley, VII ed.)

Introduction to Solids: L.V. Azaroff (Tata McGraw Hill).

Solid State Physics: A.J. Dekker (Prentice-Hall).

Essentials of Materials Science: A.G. Guy (McGraw Hill).

e-Learning Source:

https://nptel.ac.in/courses/115/104/115104109/

https://nptel.ac.in/courses/115/105/115105099/

https://nptel.ac.in/courses/113/107/113107075/

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	PSO5
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: 201-19							
Course Code	PY309	**Title of the Course**	UG Physics Project	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**0**	**0**	**8**	**4**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**					
Course Objectives	The main objective is to enhance the technical skills and to provide students industrial exposure.						

Course Outcomes	
CO1	Hands on training
CO2	Integrate class room theory with laboratory scale practice.
CO3	Understanding professional ethics of industry and code of conduct.
CO4	Increase the students' knowledge and understanding of physics.
CO5	Ensure that students receive essential training in physics laboratory safety procedures

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

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

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