



Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	CH501	Title of the Course	Polymer Chemistry	L	T	P	C
Year	Second	Semester	Third	3	1	0	4
Pre-Requisite	B.Sc. 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	Evaluate the different mechanisms of polymer preparation and their classification.
CO2	Understand the molecular weights of polymers and characterizations techniques such as IR, NMR of polymers
CO3	Analyze various processing techniques of thermoplastics and thermosetting polymer.
CO4	Understand the degradation of polymer and mechanism of oxidative degradation of rubber.
CO5	Detailed study of modification and various additives of polymer and kinetics of vulcanization of rubber

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Polymer & Polymerization	Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, polymerization methods: kinetics of addition and polycondensation polymerization (non-catalyzed and acid catalyzed); copolymerization, monomer reactivity ratios and its significance, , random, alternating, block and graft copolymers	8	1
2	Molecular weights and Characterizations of polymers	Concept of molecular weight distribution and its significance, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, analysis of polymers using IR, XRD UV-visible spectroscopy and microscopic techniques, polymer crystallinity, crystallites, Degree of polymerization.	8	2
3	Thermoplastics and Thermosetting polymers	Commodity and general-purpose thermoplastics: PE, PP, PS, PVC, Acrylic plastics. Condensation plastics: PET, PEAK PBI, PTFE, Polyvinyl Fluoride and Polyvinylidene fluoride, Epoxy Polymers and Silicon Polymers Thermosetting polymers: Elastomers and Resin, Biopolymers: Cellulose, Chitin and Chitosan	8	3
4	Polymer Degradation	Types of Degradation (Chain end and random degradation), Thermal Degradation, Mechanical degradation, Degradation by Ultrasonic Waves, Photodegradation, Oxidative Degradation and Hydrolytic degradation, Mechanism of oxidative degradation of rubber, Ozone Degradation.	8	4
5	Modifications and Additives of Polymers	Polymer Blends, Blending, Fiber-reinforced polymer (FRP), Polymer composites, Additives for Polymers: Types of Additives, Antioxidants, Light stabilizers, UV stabilizers, Lubricants, Process aids, Impact Modifiers, Flame retardant, antistatic agents. PVC stabilizers and Plasticizers), use of carbon black, cross-linking and vulcanization,	8	5

Reference Books:	
Principles of polymer chemistry: A Ravve, 2nd Edition, Kluwer Academic publications; Polymer Science: V R Gowarikar, II edition.	
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 polymer :R.J Young and P.A.Lovell.2nd Edition,Newton Thrones publication	
e-Learning Source:	
https://nptel.ac.in/content/storage2/courses/103103029/pdf/mod7.pdf2 .	
https://www.e-education.psu.edu/matse202/node/712 https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/113105028/lec20.pdf	
http://eacharya.inflibnet.ac.in/data-server/eacharya_documents/55daa452e41301c73a2cb5ac_INFIEP_208/806/ET/lec%20-3.pdf	
https://nptel.ac.in/content/storage2/courses/103103029/pdf/mod7.pdf	

Course Articulation Matrix: (Mapping of COs with POs and PSOs)																		
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	-	2	-	-	2	2	3	-	2	-	-	3	2	2	2	2	2
CO2	1	-	2	-	-	2	2	3	-	3	-	-	2	2	2	1	3	3
CO3	3	-	2	-	-	2	2	3	-	3	-	-	3	2	2	2	2	2
CO4	3	-	2	-	-	2	2	3	-	3	-	-	3	2	2	2	1	3
CO5	3	-	2	-	-	2	2	3	-	2	-	-	3	2	2	2	1	3

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CH502	Title of the Course	Petroleum Chemistry	L	T	P	C
Year	Second	Semester	Third	3	1	0	4
Pre-Requisite	BSc Chemistry	Co-requisite					
Course Objectives	To introduce the basic fundamental knowledge of petrochemicals: origin, composition, exploration and desalting of petrochemicals along with essentials, profile and methods of distillation accompanied by processing and treatments of petroleum. Also, introduce refining and cracking processes of petroleum, lubricating oils, additives and naphtha cracking with the introduction of quality procedures like ASTM/BIS/IP/DIN.						

Course Outcomes	
CO1	Introduction of origin, composition, exploration and desalting of petrochemicals create a better understanding of petroleum
CO2	Knowledge of the fundamentals, profile and methods of distillation along with processing and treatments of petroleum provide the extra strength to analyzed crude oil.
CO3	Overview, classification, stabilization, absorption and adsorption purification of hydrocarbons and fuels another significant parameter to evaluate the quality of petroleum.
CO4	Outline of refining and cracking processes of petroleum are the valuable methods that can provide the fundamentals of handling are well as an understanding of chemical changes in the petroleum.
CO5	Teach to remember lubricating oils, additives and naphtha cracking along with the introduction of quality procedures like ASTM/BIS/IP/DIN.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to Petroleum.	Introduction, origin of petroleum in nature, carbide theory, anglers theory, modern views; Petroleum exploration in India and their resources; crude oil, natural gas; composition of petroleum; preparation of crude for processing; destruction of natural emulsion of petroleum crude, desalting.	8	1
2	Methods of Petroleum distillation.	Fundamentals of preliminary distillation; Methods of petroleum distillation; Distillation of crude petroleum; Treatment of the residual liquid; Processing of liquid fuels such as petroleum and petroleum products; Product profile of refinery distillations and their specification.	8	2
3	Classification of Liquefied hydrocarbon gases and fuels.	Introduction and classification of Liquefied hydrocarbon gases and fuels; Fuels for jet engines and gas turbine engines; Dye intermediates, Lacquers, Solvent and thinner Absorptive and adsorptive purification, Sulphuric acid purification, alkaline purification, Hydrofining, New method of purification, demercaptanisation, Stabilization.	8	3
4	Petroleum Refining and Cracking.	Introduction of petroleum refining, cracking, application of cracking, synthetic petrol, Bergius process, Fischer-Tropsh process, octane number, flash point, determination of flash point, synthesis of pure chemicals from petrochemicals.	8	4
5	Lubricating oils and additives	Lubricating oils and additives, fuel quality aspects and environment aspects, Case study of Naphtha crackers and their product profile, introduction to quality procedures like ASTM/BIS/IP/DIN.	8	5

Reference Books:

- Fuel technology by Wilfrid Francis and M.C.Peters. Plenum press (1981).
- Fuel Science and Technology Handbook, James G. Speight. Marcel Dekker (1990).
- Fuels and Combustion, Samir Sarkar, 2nd.Edition, Orient Longmans (1990) Mumbai.
- Modern Petroleum refining process, B.K. Bhabana Rao, Oxford and IBHpublication.
- Petroleum chemistry and refining, James g. Speight, Taylor and francis publishers.
- Fuel technology by Wilfrid Francis and M.C.Peters. Plenum press (1981).
- Fuel Science and Technology Handbook, James G. Speight. Marcel Dekker (1990).
- Fuels and Combustion, Samir Sarkar, 2nd.Edition, Orient Longmans (1990) Mumbai.
- Petroleum refining, William L. Leffler, Pennwell publication.

e-Learning Source:

- <https://byjus.com/chemistry/petroleum/>
- <https://nptel.ac.in/content/storage2/courses/103103029/pdf/mod2.pdf>
- <https://www.shell.com/energy-and-innovation/natural-gas/liquefied-natural-gas-Ing.html>
- <https://www.e-education.psu.edu/fsc432/content/lesson-7-overview>
- https://www.stle.org/images/pdf /STLE_ORG/BOK/LS/Additives/The%20Chemistry%20and%20Function%20of%20Lubricant%20Additives.pdf

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2023-24

Course Code	CH503	Title of the Course	Agrochemistry	L	T	P	C
Year	Second	Semester	Third	3	1	0	4
Pre-Requisite	B.Sc. Chemistry	Co-requisite					
Course Objectives	Students will be able to understand of Synthesis, structure activity relationship, formulation of Organophosphates, Organochlorines and Carbamates Insecticides and their mode of actions, Classification and chemistry of Fungicides Synthesis and uses of some aromatic acid derivatives as herbicides concepts of QSAR and CAMM in pesticide design						

Course Outcomes	
CO1	Remember the concept of pesticides, Classification of Insecticides, synthesis, structure activity relationship, mode of action, uses and formulation of Organochlorines and Carbamates Insecticides.
CO2	Analyze and compare Organophosphate over Organochlorines Insecticides, Synthesis, and structure activity relationship, mode of action, uses and formulation of organophosphates.
CO3	Create the basic knowledge of chemistry of fungicides and also able to evaluate different classes like Inorganic sulfur, dithiocarbamates, antibiotics, quinones, benzimidazole.
CO4	Analyze and compare the applications and commercial synthetic methodologies of Aromatic Acid compounds, N, N-dimethylureas, anilides and new highly potent sulphonyl urea derivatives as herbicides.
CO5	Comprehension of Quantitative structure–activity relationship (QSAR), Computer-Assisted Molecular Modeling (CAMM) in pesticide design, rodenticides and Molluscicides.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Organochlorines and Carbamates Insecticides:	General Introduction and concept of pesticides, Classification of Insecticides, synthesis, structure activity relationship, mode of action, uses and formulation of following insecticides: Organochlorines: Heptachlor, Chlordane and endosulfan; Carbamates: Phenyl carbamates (Bendiocarb & Baygon), N-Methylcarbamates(Zectran, Isolan), Oxime carbamates (Oxamil, Methomylyl)	8	1
2	Organophosphorous Insecticides:	Synthesis, structure activity relationship, mode of action, uses and formulation of following Insecticides: Organophosphorous: parathion, malathion, dichlorvos, phosdrin, monocrotophos, dicrotophos, fenitrothion, fenthion, chlorpyrifos & phosalone.	8	2
3	Fungicides:	Chemistry and applications of following fungicides: Inorganic; sulfur, copper-oxychloride and organomercurials; Ceresan M, Phenyl mercury acetate Dithiocarbamates; Metham, Nabam, mancozeb Quinones; chloranil. Antibiotics; kasugamycin and griseofulvin. Benzimidazole; carbendazim, thiabendazole.	8	3
4	Herbicides	Herbicides and Molluscicides, Synthesis and uses of following: Aromatic Acid compounds; 2, 4-D, 2, 4, 5-T. N, N-dimethylureas; monuron and diuron Anilides; alachlor and butachlor, sulfonylureas; Chlorsulfuron, Metsulfuron methyl, Sulphometuron. Molluscicides: metaldehyde and carbamates;Methiocarb.	8	4
5	Insect pheromones, Repellant, QSAR and CAMM:	Pheromones; General Introduction, and application in integrated pest management (no synthesis) Repellant; Benzyl benzoate, 2-ethyl-1,3, hexanediol, Dimethylphthalate, N,N-Diethyl-m-toluamide Quantitative Structure Activity Relationship (QSAR) & Computer Assisted Molecular Modelling (CAMM) in Pesticide Design	8	5

Reference Books:

- Principles of pesticide chemistry by S.K. Handa; K.H. Bechel: Chemistry of pesticides
- Chemistry of Pesticide by N. K. Roy; H.B. scher: Advances in pesticides, formulation technology
- Pesticide Chemistry By G. Matolcsy, M. Nádasy and V. Andriská; N.N. Melnikov: Chemistry of pesticides (Springer)
- Pesticide Management and Insecticide Resistance By Academic Press; M.B. Green, G.S. Hartley, T.E. West: Chemicals for crop protection and pest management (Pergamon).

e-Learning Source:

<https://www.youtube.com/watch?v=p32vHoW8Awk>

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

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CH504	Title of the Course	Cosmetics And Perfumery	L	T	P	C
Year	Second	Semester	Third	3	1	0	4
Pre-Requisite	BSc with Chemistry	Co-requisite					
Course Objectives	Students to understand the Chemical Nature and Utility of Emulsifiers, lipid components, humectants, and fragrances. Cosmetic Raw Materials, Face powder and lipstick, Cosmetic for Skin, Hair products, Herbal Cosmetics						

Course Outcomes	
CO1	Evaluate the concept of Chemical Nature and Utility of Emulsifiers, lipid components, humectants, and fragrances.
CO2	Analyze Chemical Nature and Utility of colors (dyes and pigments), preservatives and antioxidants in cosmetics. Technical requirements, basic components and formulation of face powders and lipstick.
CO3	Create the basic knowledge of general skin problems, purpose, types and key ingredients of skin cleansing, skin toners, moisturizers, nourishing, protective, sunscreen and bleaching products. Antiperspirants and deodorants.
CO4	Analyze general hair problems and scalp disorders. Shampoos (requirements, classification, ingredients and special additives for hair condition and scalp health). Hair colorants and Chemical depilatories
CO5	Comprehension of the plant materials used in cosmetics. Use of herbs in different forms. Herbal cosmetics for skin and Herbal Cosmetics for hair.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Cosmetic Raw Materials	Study of Chemical Nature and Utility of Emulsifiers (natural, synthetic and finely dispersed solid), lipid components (oils, fats, waxes), humectants (inorganic, organic and organo-metallic) and perfumes / fragrances (plant oils, animal secretions, chemical substances).	8	1
2	Cosmetic Raw Materials, Face powder and lipstick	Study of Chemical Nature and Utility of colors (dyes and pigments), preservatives and antioxidants in cosmetics. Technical requirements, basic components and formulation of face powders and lipstick.	8	2
3	Cosmetic for Skin	Introduction to general skin problems, purpose, types and key ingredients of skin cleansing, skin toners, moisturizers, nourishing, protective (barrier), sunscreen and bleaching products. Antiperspirants and deodorants (mechanism, ingredients and formulation).	8	3
4	Hair products	Introduction to general hair problems and scalp disorders. Shampoos (requirements, classification, ingredients and special additives for hair condition and scalp health). Hair colorants (temporary, semi-permanent and gradual colorants and their dyeing system). Chemical depilatories.	8	4
5	Herbal Cosmetics	A comprehensive study of the plant materials used in cosmetics. Use of herbs in different forms. Herbal cosmetics for skin (cleaning creams, moisturizing creams, masks, body lotions, massage preparations, nourishing creams). Herbal Cosmetics for hair (conditioners, oils, shampoo, dyes).	8	5

Reference Books:

Perfumes, soaps, detergents and cosmetics-Bhatia, Volume I & II

Poucher's Perfumes, Cosmetics and Soaps (Vol. III), Cosmetics (Vol. I & II) - Hilda Butler

e-Learning Source:

<https://www.youtube.com/watch?v=z15PZHkaQRg>

<https://www.science.org.au/curious/people-medicine/chemistry-cosmetics>

<https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-mm13/>

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107217/lec3.pdf

http://priede.bf.lu.lv/groz/AuguFiziologijas/Augu_resursu_biologija/gramatas/Herbal%20Principles%20in%20Cosmetics.pdf

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

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CH505	Title of the Course	Food Chemistry	L	T	P	C
Year	Second	Semester	Third	3	1	0	4
Pre-Requisite	BSc 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 and international food laws 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, minerals and food additives.
CO3	Describe the principles in food processing techniques and differentiate food preservation methods like heat preservation and cold preservation, food packaging.
CO4	Analyze the importance of food safety and food related physical, chemical and biological hazards.
CO5	Understanding different fermentation techniques.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Governmental regulation	Introduction, Food laws and standards: Indian and international food safety laws and standards; Quality and safety assurance in food industry; BIS Laboratory Services and Certification by BIS, Food labeling.	8	1
2	Constituents of foods & their nutritive aspects	Carbohydrates, Proteins, Fats and oils, Vitamins and Minerals. Food additives: Preservatives, Antioxidants, Chelating agents, Surface active agents, Stabilizing and Thickening agents, Bleaching and Maturing agents, Buffering agents, Colouring agents, Sweetening agents & Flavoring agents.	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 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: HACCP method	8	4
5	Fermentation and other uses of Microorganisms	Industrial uses of bacteria, and yeast lactic acid fermentation, vinegar production, amino acid production, alcoholic fermentation, Bakers yeast, food yeast industrial uses of molds, Microbial Transformation: Type of bioconversion reaction, procedures of biotransformation.	8	5

Reference Books:

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

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

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

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	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	1	3			3	3	3	-	-	2
CO2	3	1	1	-	2	2		3	3	2	2	2	3
CO3	3	1	1	-	2	2	2	3	3	2	2	2	3
CO4	3	1	1	-	2	2		3	3	2	2	2	3
CO5	3	1	1	-	2	2	2	3	3	2	2	2	3

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	CH506	Title of the Course	Bioinorganic And Supramolecular Chemistry	L	T	P	C
Year	Second	Semester	Third	3	1	0	4
Pre-Requisite	B.Sc. Chemistry	Co-requisite					
Course Objectives	The course aims at providing understanding of the chemistry of d-block metals in metalloproteins and of metal based bioactive compounds, use of metals in medicine, fundamentals of molecular recognition, interactions responsible for the formation of supramolecular systems and applications of supramolecular devices.						

Course Outcomes	
CO1	Student would be able to understand the role of metal ions in biological system.
CO2	Students evaluate fundamentals of enzyme reactions and metalloenzymes.
CO3	Students would develop the concept of metal acid reactions, metals used in diagnosis and administration of drugs.
CO4	Students would restate difference between different modes of molecular reactions.
CO5	Students would able to apply the concepts of supramolecular chemistry.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Metal ions in Biological functions	A brief introduction to bio-inorganic chemistry. Essential and trace metal ions in biological systems with special reference to Na ⁺ , K ⁺ and Mg ²⁺ ions: Na/K pump; Role of Mg ²⁺ ions in energy production. Role of Ca ²⁺ in blood clotting, stabilization of protein structures and structural role (bones).	8	1
2	Metalloenzymes	Enzyme, coenzyme, apoenzyme and holoenzyme, Zinc enzymes: carboxypeptidase, carbonic anhydrase and alcohol dehydrogenase. Iron enzymes-catalase and peroxidase. Copper enzymes -superoxide dismutase. Molybdenum enzymes –xanthine oxidase.	8	2
3	Metal-Nucleic Acid Interactions	Metal ions and metal complex interactions,–nucleic acids. Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs. cis-platin, indication and contra indications. Administration of drug and its antidote, use of antihistamine, mannitol, epinephrine and steroid	8	3
4	Supramolecular Chemistry	Concepts and language. Molecular recognition, principle, molecular receptors for different types of molecules including cationic and anionic substrates, design and synthesis of coreceptor molecules.	8	4
5	Applications of Supramolecular Species/Compounds	Supramolecular reactivity and catalysis, Transport processes and carrier design, Supramolecular devices: electronic, ionic, switching and light conversion devices, Some example of self-assembly in supramolecular chemistry.	8	5

Reference Books:

- New Concise Inorganic Chemistry by J.D. Lee Edition III Compton Printing Ltd London.
- Principles of Bioinorganic Chemistry, Stephen J. Lippard & Jeremy M. Berg, University Science Books.
- Bioinorganic and supramolecular Chemistry, Ajay Kumar Bhagi and G. R. Chatwal, First Edition, Himalaya Publishing House
- Bioorganic, Bioinorganic and Supramolecular Chemistry, P.S. Kalsi and J.P. Kalsi, Fourth Edition, New Age International Publishers.
- Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Trevor Palmer and Philip L. Bonner Second Edition, Woodhead Publishing
- Supramolecular Chemistry: Concepts & Perspectives, Lehn, J. M. Print ISBN:9783527293124 Wiley-VCH (2006).

e-Learning Source:

- <https://archive.nptel.ac.in/noc/courses/noc19/SEM2/noc19-cy27/>
- <https://www.digimat.in/nptel/courses/video/104104109/L01.html>
- <https://www.youtube.com/watch?v=mdwUnjipR28>

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

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session:2015-16							
Course Code	CH507	Title of the Course	Industrial Chemistry Practical-3	L	T	P	C
Year	Second	Semester	Third	0	0	8	4
Pre-Requisite	BSc. with Chemistry	Co-requisite					
Course Objectives	<ul style="list-style-type: none"> • Imparting of scientific methodology. • Development of practical/technical skills. • Ability to work effectively and safely in a laboratory environment. • Developing transferable skills (team work, time management). • Enhancing communication skill. 						

Course Outcomes	
CO1	Preparation of polymers.
CO2	Preparation of cosmetic products.
CO3	Estimation of key ingredients present in cosmetic products.
CO4	Analysis of food samples.
CO5	Estimation of food samples.

Exp. No.	Title of the Experiment	Content of unit	Contact Hrs.	Mapped CO
1	Phenol formaldehyde resin.	Preparation of Phenol formaldehyde resin.	2	1
2	Urea formaldehyde resin.	Preparation of Urea formaldehyde resin.	2	1
3	Nylon 66.	Preparation of Nylon 66.	2	1
4	Soap	Preparation of soap.	2	2
5	Shampoo	Preparation of shampoo.	2	2
6	Vanishing cream	Preparation of vanishing cream.	2	2
7	Hand lotion	Preparation of hand lotion.	2	2
8	Lather shaving cream	Preparation of lather shaving cream.	2	2
9	Calcium thioglycolate	Determination of calcium thioglycolate / thioglycolic acid in the depilatories.	2	3
10	Lakes and fillers	Determination of lakes and fillers in the given lipstick.	2	3
11	Zinc-pyrithione/	Determination of zinc-pyrithione/pH in the given shampoo.	2	3
12	Acetic acid	Determination of acetic acid content in the given sample of food.	2	4
13	Protein content	Determination of protein content in the given sample of food.	2	4
14	Fat content	Determination of fat content in the given sample of food.	4	4
15	Salt content	Determination of salt content in the given sample of butter.	4	4
16	Moisture content	Determination of moisture content in the given sample by K. F. titre.	2	5
17	Sugar /glucose	Determination of sugar /glucose content in the given sample.	2	5
18	Ascorbic acid	Estimation of ascorbic acid in the given fruit juices.	2	5

Reference Books:

Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, Pragati Edition.

e-Learning Source:

<https://youtu.be/r2LZxmLtdqU>

<https://youtube.com/watch?v=q8IMKft663I&feature=share>

<https://youtu.be/eA9I2MkWMW0>

<https://youtu.be/gYg2sFqkptc>

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

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



Name & Sign of Program Coordinator	Sign & Seal of HoD
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Department of Chemistry
Study and Evaluation Scheme

Program: Master of Science (Industrial Chemistry)

Year: Second / Semester: Fourth

S. No.	Course code	Course Title	Type of Paper	Period/ hr./week			Evaluation Scheme				Subject Total	Total Credits	Attributes						United Nations Sustainable Development Goals (SDGs)			
				L	T	P	CA	TA	Total	ESE			Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value		Professional Ethics		
THEORIES																						
1.	CH508	Intellectual Property Rights	Core	03	01	00	40	20	60	40	100	4	✓					✓	✓	-	-	
2.	CH509	Green Chemistry	Elective	03	01	00	40	20	60	40	100	4	✓	✓	✓		✓		Climate Action			
3.	CH510	Industrial Hygiene and Chemical Safety	Elective										✓	✓	✓		✓	✓	✓	Good Health and Well-being		
4.	CH511	Seminar Presentation	Core	00	00	04	00	00	00	100	100	2			✓				✓	-	-	
5.	*CH512	Industrial Training & Project Evaluation	Core	00	00	00	00	00	00	300	300	10	✓	✓	✓		✓	✓	✓	-	-	
Total				06	02	04	80	40	120	480	600	20										

L = Lecture, T = Tutorial, P = Practical, CA = Continuous Assessment, TA = Teacher's Assessment, ESE = End Semester Examination; Sessional = CT+TA; Subject Total = Sessional + ESE

* The Evaluation scheme for the Industrial Training:

Course Title	Course Code	Dissertation	Presentation	Viva/Discussion	Total
Industrial Training & Project Evaluation	CH512	200	50	50	300



Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CH508	Title of the Course	Intellectual Property Rights (IPR)	L	T	P	C
Year	Second	Semester	Fourth	3	1	0	4
Pre-Requisite	B.Sc. with Chemistry	Co-requisite					
Course Objectives	Professional ethics will be inculcated in students in context to Intellectual Property Rights in India and abroad. Various IPR laws, procedures governing the filing of patents in India and abroad and various treaties and conventions governing IPR will be introduced.						

Course Outcomes	
CO1	Awareness is created among students regarding the importance of ethics, IPR and laws for protection.
CO2	An analysis of the genesis and development of IPR in India is done in the form of various laws and acts.
CO3	An understanding of different branches of IPR including copyrights and patents etc. is inculcated.
CO4	How various conventions and treaties can be applied to protect intellectual rights would be taught for the creation of innovations.
CO5	Evaluation of malpractice and infringements and penalties would be analysed.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Overview of Intellectual Property	Introduction and the need for intellectual property right (IPR). IPR in India – Genesis and Development IPR in abroad. Some important examples of IPR	8	1
2	Patents	Macro-economic impact of the patent system. Patent and kind of inventions protected by a patent. Patent document. Protection of inventions. Granting of patent. Rights of a patent. Patent protection. Protection of inventions by patents. Searching, Drafting and Filing of a patent. The different layers of the international patent system (national, regional and international options).	8	2
3	Patents & Copyright	Utility models. Differences between a utility model and a patent. Trade secrets and know-how agreements. Copyright: Introduction, How to obtain, Differences from Patents. Related rights. Distinction between related rights and copyright. Rights covered by copyright.	8	3
4	Trademarks	Trademark, Rights of trademark. Kind of signs used as trademarks. Types of trademark. Function does a trademark perform. Protection and registration of trademark. Duration of trademark protection. Well-known marks and their protection. Domain name and it relate to trademarks.	8	4
5	Industrial Designs	Industrial design. Protection of industrial designs. Kind of protection is provided by industrial designs. Duration of protection. IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.	8	5

Reference Books:

- Ajit Parulekar and Sarita D' Souza, Indian Patents Law – Legal & Business Implications; Macmillan India Ltd, 2006
- B.L.Wadhra; Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India2000
- P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi , 2010
- N.K. Acharya; Textbook on intellectual property rights, Asia Law House (2001).
- Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
- P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).

e-Learning Source:

- https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/627956/IP-Rights-in-India.pdf
- <https://nptel.ac.in/courses/109106128/>
- https://nptel.ac.in/content/storage2/courses/downloads/121106007/Assignment-6_noc18_ge12_108.pdf
- https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/109105112/lec25.pdf
- <https://www.shiksha.com/careers/industrial-designer-63>

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

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2019-2020							
Course Code	CH509	Title of the Course	Green Chemistry	L	T	P	C
Year	Second	Semester	Fourth	3	1	0	4
Pre-Requisite	BSc. with Chemistry	Co-requisite	-				
Course Objectives	This course is designed for postgraduate students of chemistry and industrial chemistry as a broad base introduction to analytical instrumentation techniques for the measurement of different chemical and physical properties of compounds and materials (composition, structure, etc.). After successfully completion of course, the student will be able to understand the working principle and applications of various modern analytical techniques as well as their operation.						

Course Outcomes	
CO1	Students would be able to create new routes for the synthesis of useful compounds without consuming harmful solvents.
CO2	Students would be able to understand the principles of green chemistry
CO3	Students would be able to apply the important tools for the synthesis of useful compounds without harming the environment.
CO4	Students would restate the difference between different modes of chromatographic separation; apply knowledge of qualitative and quantitative analysis in various fields of chemical, pharmaceutical industry etc.
CO5	Students would be able to illustrate the future of green chemistry

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction	Definition and concept of Green Chemistry, Need for Green Chemistry, Goals of Green Chemistry, Emergence of green Chemistry, Limitations/Obstacles in the pursuit of the goals of Green Chemistry.	8	1
2	Principles of Green Chemistry and Designing a Chemical synthesis	Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/minimization of hazardous/toxic products; designing safer chemicals different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes..	8	2
3	Green Synthesis/Reactions -I	1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to strecker synthesis), citral, ibuprofen, paracetamol, furfural. 2. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzoic acid), Oxidation (of toluene, alcohols). Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels Alder Reaction, Decarboxylation. Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.	8	3
4	Green Synthesis/Reactions -II	1. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizzaro reaction, Strecker synthesis, Reformatsky reaction. 2. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayon", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in Organic Syntheses; Biocatalysis in Organic Syntheses.	8	4
5	Future Trends in Green Chemistry	Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.	8	5

Reference Books:

- V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
 P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
 M.C. Cann & M.E. Connolly: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
 M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

e-Learning Source:

- <https://www.acs.org/content/acs/en/greenchemistry/principles/12-principles-of-green-chemistry.html>
https://www.youtube.com/watch?v=SvRe_wc0w3Q
<https://extension.harvard.edu/blog/green-chemistry-and-the-future-of-sustainability/>

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

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2021-22							
Course Code	CH510	Title of the Course	Industrial Hygiene And Chemical Safety	L	T	P	C
Year	Second	Semester	Fourth	3	1	0	4
Pre-Requisite	B.Sc. with Chemistry	Co-requisite					
Course Objectives	The purpose of the industrial hygiene and chemical safety course provides the prevention and control of hazards arising from work processes is occupational hygiene. The goals of occupational hygiene include the protection and promotion of workers' health, the protection of the environment and contribution to a safe and sustainable development.						

Course Outcomes	
CO1	Students will be able to understand the objectives, principles and practices of industrial hygiene cummings memorial lecture American industrial hygiene association
CO2	Students will create the science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stresses arising in or from the workplace, which may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community.
CO3	Students will be able to understand about the biological hazards can cause serious infections. These can be chronic, meaning they have a rapid onset and last for a short time, or acute, meaning they last for a long time and/or constantly recur. Both acute and chronic infections can be serious and even fatal.
CO4	Students will be able to understand about the key challenges of Some occupational hygienists working in manufacturing, petrochemical, pharmaceutical, steel, mining and other industries.
CO5	Students will have a firm foundation on concept of hazardous chemicals through different types of exposures, including: Inhalation (breathing the chemical), Absorption (direct contact with the skin), Ingestion (eating or drinking the chemical).

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Industrial hygiene	Concept, air and biological monitoring, occupational disease, operational control measures, personal protective equipments	8	1
2	Occupational Safety; Health and Environment Management	Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards	8	2
3	Safety and Health Management	Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Importance of Industrial safety, role of safety department, Safety committee and Function.	8	3
4	Chemical Hazards	Classification of hazardous chemicals, storage, transportation, handling, risk assessments, challenges and solutions.	8	4
5	Radiation and Industrial Hazards	Types and effects of radiation on human body, Measurement and detection of radiation intensity, Effects of radiation on human body, Measurement –disposal of radioactive waste, Control of radiation. Different air pollutants in industries, Effect of different gases and particulate matter, acid fumes, smoke, fog on human health.	8	5

Reference Books:

- The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai
- Grimaldi and Simonds , Safety Management, AITBS Publishers , New Delhi (2001)
- Industrial Safety –National Safety Council of India
- R.K.Jain and Sunil S.Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers , New Delhi (2006)
- Slote.L, Handbook of Occupational Safety and Health, John Willey and Sons, NewYork .
- Frank P Lees – Loss of prevention in Process Industries, Vol. 1 and 2, Butterworth- Heinemann Ltd., London (1991).
- R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers , New Delhi(2006)

e-Learning Source:

- <https://www.osha.gov/Publications/OSHA3143/OSHA3143.html>
- <https://nptel.ac.in/courses/114106017/>
- https://www.academia.edu/38181906/SAFETY_AND_HEALTH_MANAGEMENT_AND_ORGANIZATIONAL_PRODUCTIVITY_edited.pdf
- <https://nptel.ac.in/content/storage2/courses/108101092/Week-2-RF-Radiation-Hazards-July2016-extra.pdf>
- https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/103107156/lec56.pdf

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

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2019-2020							
Course Code	CH511	Title of the Course	Seminar Presentation	L	T	P	C
Year	Second	Semester	Fourth	0	0	4	2
Pre-Requisite	BSc. with Chemistry	Co-requisite	-				
Course Objectives	<ul style="list-style-type: none">To develop students' communication and discussion skillsIncrease vocabulary knowledge, learn about communication style, develop learner autonomy.To build confidence to use English for oral presentation.To develop the ability to seek clarification and defend the ideas of others effectively.						

Course Outcomes	
CO1	To develop and improve the communication skills
CO2	To develop discussion and leadership abilities
CO3	Skills for the development of demonstration abilities
CO4	To develop skills for effective power point presentation
CO5	To understand importance of gestures and body language during presentation

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

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

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2019-2020							
Course Code	CH512	Title of the Course	Industrial Training & Project Evaluation	L	T	P	C
Year	Second	Semester	Fourth	0	0	0	10
Pre-Requisite	BSc. with Chemistry	Co-requisite	-				
Course Objectives	To provide the industrial exposure and enhance technical skills of students						

Course Outcomes	
CO1	Hands on training
CO2	Integrate class room theory with laboratory practice.
CO3	Understanding professional ethics of industry and code of conduct.
CO4	Essential training in laboratory safety procedures
CO5	Compilation of data and report writing

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