



Re- accredited with A ++ Grade (CGPA 3.65) by NAAC
Category- I University Status awarded by UGC

No. 2026/June/AAMS/C- 161/48209

Date: 5th June, 2026

CIRCULAR:-

Attention of all the Principals of the Affiliated Colleges, all Academic Heads of University Departments, the Directors of the Recognized Institutions/Centres, Director, Centre for Distance & Online Education, Director, Dharmaveer Anand Dighe Thane Sub-Campus, Co-ordinator, School of Engineering and Applied Sciences, Kalyan Sub-Campus, Director, Chitrakar Padmabhushan Dr.Dhananjay Keer Ratnagiri Sub-Campus, Director, Sindhudurg Sub-Campus, Principal, Vishwabhushan Bharatratna Dr. B. A. Ambedkar College, Ambadave, Ratnagiri and Principal, V.V. Dalvie College, Talere, Sindhudurg is invited to this office Circular No. AAMS/ICD/2025-26/ 37 of dated 27 May, 2025 relating to the NEP UG Syllabus.

They are hereby informed that the recommendations made by the **Board of Studies in Chemistry** at its meeting held on 28th March, 2026 and subsequently passed by the Board of Deans at its meeting held on 15th May, 2026 vide item No.1 (c) have been accepted by the Academic Council at its meeting held on 18th May, 2026 vide item No.6.3 (N). In accordance therewith syllabus of **B.Sc. (Chemistry) (Scheme - III) (Sem V & VI) (NEP 2020)** is introduced as per appendix with effect from the academic year 2026-27.

(The said circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
05th June, 2026

To


(Dr. Prasad Karande)
REGISTRAR

All the Principals of the Affiliated Colleges, all Academic Heads of Departments, the Directors of the Recognized Institutions/Centres, Director, Centre for Distance & Online Education, Director, Dharmaveer Anand Dighe Thane Sub-Campus, Co-ordinator, School of Engineering and Applied Sciences, Kalyan Sub-Campus, Director, Chitrakar Padmabhushan Dr.Dhananjay Keer Ratnagiri Sub-Campus, Director, Sindhudurg Sub-Campus, Principal, Vishwabhushan Bharatratna Dr. B. A. Ambedkar College, Ambadave, Ratnagiri and Principal, V.V. Dalvie College, Talere, Sindhudurg

AC./6.3 (N)/18/5/2026

Copy forwarded with Compliments for information to:-

- 1) The Chairman, Board of Deans,
- 2) The Dean, Faculty of Science,
- 3) The Chairman, **Board of Studies in Chemistry**
- 4) The Director, Board of Examinations and Evaluation,
- 5) The Director, Department of Students Development,
- 6) The Director, Department of Information & Communication Technology,
- 7) The Director, Centre for Distance and Online Education (CDOE)Vidyanagari,
- 8) The Deputy Registrar, Admission, Enrolment, Eligibility & Migration Department (AEM).

As Per NEP 2020

University of Mumbai



Syllabus for Major Vertical – 1, 4 & 6 (Scheme – III)

Faculty of Science & Technology		
Board of Studies in Chemistry		
Name of the Programme – B.Sc. (Chemistry)		
U.G. Third Year Programme	Exit Degree	B.Sc. (Chemistry)
Semester	V & VI	
From the Academic Year	2026-27	

University of Mumbai



(As per NEP 2020)

Sr. No.	Heading	Particulars
1	Title of program O: _____	B.Sc. (Chemistry)
2	Exit Degree	B.Sc. (Chemistry)
3	Scheme of Examination R: _____	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	Standards of Passing R: _____	40%
5	Credit Structure R: SU- 525 E (III) R: SU- 525 F (III)	Attached herewith
6	Semesters	Sem. V & VI
7	Program Academic Level	5.5
8	Pattern	Semester
9	Status	New
10	To be implemented from Academic Year	2026-27

Sd/-
Sign of the BOS
Dr. Sunil Patil
Co-ordinator
BOS in Chemistry

Sd/-
Sign of the
Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science &
Technology

Sd/-
Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science &
Technology

Credit Structure (Sem. V & VI)

	R: SU- 525 E (III)									
Vertical		1	2		3	4	5	6		
Level	Semester	Major 1	Major 2 (Minor)	Major 3 (Minor)	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC,RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.
		M1	M2	M3						
5.5	V	10+4 (Mandatory + Elective) Advanced Physical and Analytical Chemistry - Paper I (2) Advanced Analytical and Inorganic Chemistry – Paper II (2) Advanced Inorganic and Organic Chemistry – Paper III (2) Practicals in Advanced Chemistry – I (2) IKS in Chemistry (2) Elective Drugs and Dyes / Heavy and Fine Chemicals/ Petrochemicals – I (2) Practicals in Drugs and Dyes / Heavy and Fine Chemicals/ Petrochemicals – I (2)	2	----	----	VSC (Practical) : 2 Techniques in Chemical Analysis and Synthesis (2)	----	CC:2 CEP:2	22	UG Degree 132
R: SU- 525 F (III)										

	VI	14+4 (Mandatory + Elective) Advanced Physical and Analytical Chemistry - Paper IV (2) Advanced Analytical and Inorganic Chemistry – Paper V (2) Advanced Inorganic and Organic Chemistry – Paper VI (2) Practicals in Advanced Chemistry II (2) Practicals in Advanced Chemistry III (2) Elective Drugs and Dyes / Heavy and Fine Chemicals/ Petrochemicals – II (2) Practicals in Drugs and Dyes / Heavy and Fine Chemicals/ Petrochemicals – II (2)	----	----	----	----	----	OJT :4	22	
	Cum Cr.	52	18	8	10	8+2+2	6+4+2	8+6+4	132	
Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major										

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Community Engagement Project, CC – Co-Curricular, RP – Research Project]

[* 2 Credit IKS Major paper (Core Subject Specific Theory may be included in Sem III or V)]

Program Structure for Sem. V & VI (NEP 2020)

Vertical No		Paper Title	Credits
Sem. V			
1.	Mandatory	1. Advanced Physical and Analytical Chemistry - Paper I	2
		2. Advanced Analytical and Inorganic Chemistry – Paper II	2
		3. Advanced Inorganic and Organic Chemistry – Paper III	2
		4. Practicals in Advanced Chemistry - I	2
		5. IKS in Chemistry	2
	Electives	1. Drugs and Dyes / Heavy and Fine Chemicals/ Petrochemicals – I	2
		2. Practicals in Drugs and Dyes / Heavy and Fine Chemicals/ Petrochemicals - I	2
2.	Minor (To be selected from other discipline)		4 (2+2)
4.	VSC (Practical)	Techniques in Chemical Analysis and Synthesis	2
6.	CEP (To be selected from CEP topic list)		2
Credits			22
Sem. VI			
1.	Mandatory	1. Advanced Physical Chemistry – Paper IV	2
		2. Advanced Inorganic Chemistry – Paper V	2
		3. Advanced Organic Chemistry – Paper VI	2
		4. Advanced Analytical Chemistry – Paper VII	2
		5. Practicals in Advanced Chemistry - II	2
		6. Practicals in Advanced Chemistry - III	2
		7. Practicals in Advanced Chemistry - IV	2
	Electives	1. Drugs and Dyes / Heavy and Fine Chemicals/ Petrochemicals – II	2
		2. Practicals in Drugs and Dyes / Heavy and Fine Chemicals/ Petrochemicals - II	2
6.	VI	OJT	4
Credits			22
Total Credits			44

SEM V
Vertical – 1
Electives
(2+2)

Title of Paper: Heavy and Fine Chemicals - I

Sr. No.	Heading	Particulars
1	Description of the course : Including but Not limited to :	Heavy and Fine Chemicals I introduces the classification, manufacture, properties and industrial applications of important heavy and fine chemicals. The course provides an overview of major chemical industries, manufacture of key inorganic chemicals, fertilizers, industrial solvents, perfumes, flavours and selected drug intermediates. It also covers economic and environmental aspects of chemical manufacturing processes and introduces fluorinated organic compounds. Emphasis is placed on understanding industrial relevance, chemical processes and applications in pharmaceutical, agrochemical and speciality chemical industries.
2	Vertical :	Major (Elective)
3	Type :	Theory
4	Credit:	2 credits
5	Hours Allotted :	30 Hours
6	Marks Allotted:	50 Marks
7	Course Objectives: The course aims to: COB1: Develop understanding of classification and scope of heavy and fine chemicals and their role in chemical industry and economy. COB2: Provide knowledge of properties, structure, preparation and industrial applications of important inorganic chemicals such as silicates, nitric acid, sodium dichromate and chromium trioxide. COB3: Explain preparation, properties and industrial significance of fertilizers such as urea, superphosphate, ammonium nitrate and ammonium sulphate. COB4: Create awareness of economic aspects of chemical manufacturing processes including raw materials, energy requirements, manpower and environmental considerations.	

	COB5: Introduce industrially important fine chemicals such as perfumes, flavours, solvents and drug intermediates along with their synthesis and applications. COB6: Develop understanding of basic principles of fluorination reactions and industrial importance of fluoroaromatic compounds.
8	Course Outcomes: At the end of the course, students will be able to: CO1: Classify heavy and fine chemicals and explain their industrial importance, including key players in the Indian chemical industry. CO2: Describe the preparation, properties, and applications of silicates, nitric acid, sodium dichromate, chromium trioxide, and fertilizers. CO3: Evaluate factors affecting the economics of chemical manufacturing processes and prepare a basic project report for an MSME chemical unit. CO4: Explain the synthesis, classification, and industrial applications of perfumes, flavours, and industrial solvents, including green solvent concepts. CO5: Apply concepts of sustainability such as green chemistry and nano-encapsulation in modern chemical industries and fluorination techniques and reactions.
9	Modules: Module 1: 1.1 Introduction to Heavy and Fine Chemicals (4 Hours) 1.1.1. Introduction, commercial classification of chemicals, Classification of heavy and fine chemicals. 1.1.2. Overview of Heavy and Fine Chemical Industry 1.1.3. Introduction to Major Indian chemical industries (GSFC, GNFC, Tata Chemicals, RCF, FACT etc.). 1.1.4. Contribution of Heavy and fine chemical industries to GDP of India. 1.2 Silicates (3 Hours) 1.2.1 Introduction to silicates. 1.2.2 Properties, structure and types of silicates. Preparation of sodium silicate. 1.2.3. Applications of sodium silicate. 1.3 Manufacture and applications of the following: (4 Hours) 1.3.1 Nitric acid 1.3.2 Sodium dichromate 1.3.3 Chromium trioxide 1.4 Fertilizers: Preparation, properties and uses of: (4 Hours) 1.4.1 Urea 1.4.2 Superphosphates 1.4.3 Ammonium nitrate 1.4.4 Ammonium Sulphate

Module 2:

2.1 Brief idea about the economic aspects of chemical manufacturing processes with respect to (3 Hours)

- 2.1.1 Location
- 2.1.2 Raw materials
- 2.1.3 Energy
- 2.1.4 Capital
- 2.1.5 Manpower
- 2.1.6 Ecological aspects
- 2.1.7 Tax benefits.

2.2 Brief account of perfumes and flavours (4 Hours)

- 2.2.1 Perfumes: Introduction, classification (ethers, esters and essential oils) composition, formation, blending and applications. Synthesis of α and β -ionone's from citral.
- 2.2.2 Flavours: Introduction, classification (natural and synthetic), applications of vanillin, vanillin., coumarin, (structures) , synthesis of vanillin
- 2.2.3 Nano-encapsulation of flavours: cyclodextrin inclusion complexes for controlled release — industrial applications (food, pharma).

2.3 Industrial solvents (3 Hours)

- 2.3.1. Introduction – Classification of solvents (Q3C Class I/II/III) as per ICH guidelines.
- 2.3.2 Brief idea of green solvents
- 2.3.3 Manufacture and uses of ethyl acetate, isopropyl alcohol, Acetone.

2.4 Introduction to drugs and drug intermediates (3 Hours)

- 2.4.1 Classification of drugs with one example each. API and drug intermediate terminology. India's dominance in generic APIs,
- 2.4.2 Synthesis and uses of the following i) p-acetyl amino benzenesulphonyl chloride from Aniline ii) Ethambutol iii) Miconazole iv) Diazepam.

2.5 Fluoroaromatics (2 Hours)

Introduction, important reagents used for fluorination, Halex reaction, Super Halex reaction, Preparation of ortho-fluorotoluene and 3-chloro-4-fluoro aniline.

10

Reference Books

- 1 C. D. Dryden: Outlines of Chemical Technology, edited & revised by M. Gopala Rao & Marshall Sittig, East West Press, New Delhi.2008.
- 2 Faith Keyes and Clerk's Industrial Chemicals, Wiley Inter-science, 4th Edn., 1975.
- 3 Kirk & Othmer: Encyclopaedia of Chemical Technology, John Wiley and sons. John Wiley & Sons, New York, 4th Edition, Volume 5,1992.
- 4 Industrial Inorganic Chemistry- Büchner, Schliebs, Winter, translated by David R. Terrell,VCH/Wiley publisher New York., 2nd edition, 2000
- 5 K. Welssermel, H. J. Arpe, Industrial Organic Chemistry- VCH Publishers, New York.1997
- 6 B. Pearson- Speciality Chemical Innovations in Industrial Synthesis, Kluwer Academic Publishers, 1991.

	7 Wilson & Giswold's- Text Book of Organic Medicinal and Pharmaceutical Chemistry , <u>John M. Beale Jr.</u> and <u>John H. Block</u>, Wolters Kluwer India, 12th edition, 2010. 8 R. S. Satoskar and S. D. Bhandarkar, Phramacology and Pharmacotherapeutics, Polpular prakashan , 21st edition, 2009. 9 B. K. Sharma, Industrial Chemistry Goyal publishing house, Meerut, 2000. 10 Jems A. Kent, Riegel's Hand Book of Industiral Chemistry, Springer Nature, 9th Edition, 1992. 11 E. Stocchi, Industrial Chemistry, Ellis Horwood Ltd. UK, Vol- I, 1990. 12 Wiseman and Peter, An Introduction to Industrial Organic Chemistry, Applied Science Publishers, 1972. 13 Anna Regini Anthony, Overview of Bulk and Fine Chemicals by Walnutpublication.com , 2021. 14 Peter Pollak, Fine Chemicals, The Industry and The Business, A John Wiley & Sons, Inc., Publication, Second Edition, 2011. 15 Peter Bamfield, Research and Development in The Chemical and Pharmaceutical Industry By Third Completely Revised And Enlarged Edition, Publication WILEY-VCH Verlag Gmbh & Co. Kgaa, Weinheim 2006	
11	Internal Continuous Assessment: 40%	External, Semester End Examination 60% Individual Passing in Internal and External Examination
12	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, creative writing, assignment (any 2)	

Title of Paper: Practicals in Heavy and Fine Chemicals - I

Sr. No.	Heading	Particulars
1	Description of the course : Including but Not limited to :	Practicals in Heavy and Fine Chemicals – I provides hands-on training in synthesis and quantitative analysis of selected heavy and fine chemicals of industrial and pharmaceutical importance. The course develops practical skills in preparation of organic compounds and inorganic salts, determination of active ingredients in commercial samples, and estimation of metal ions using titrimetric and complexometric methods. Emphasis is placed on reaction techniques, stoichiometric calculations, accuracy in measurement, yield determination, and application of good laboratory practices relevant to chemical and pharmaceutical industries.
2	Vertical :	Major (Elective)
3	Type :	Practicals
4	Credit:	2 credits
5	Hours Allotted :	60 Hours
6	Marks Allotted:	50 Marks
7	Course Objectives The course aims to: COB1: Develop practical skills in synthesis of organic compounds and inorganic salts used in heavy and fine chemical industries. COB2: Provide understanding of reaction principles involved in oxidation, nitration and condensation reactions. COB3: Develop ability to determine concentration of chemical substances in commercial samples using titrimetric methods. COB4: Impart skills in estimation of pharmaceutical ingredients using back titration and complexometric titration techniques.	

	COB5: Develop competence in quantitative determination of metal ions using EDTA titration methods. COB6: Inculcate accuracy in experimental work, calculation of percentage yield and reporting of results following good laboratory practices.
8	Course Outcomes: At the end of the course, students will be able to: CO1: Synthesize selected organic compounds such as benzil, chalcone, nerolin and p-nitrobenzoic acid and calculate percentage yield. CO2: Prepare inorganic salt copper sulphate pentahydrate and calculate percentage yield from experimental data. CO3: Determine concentration of phosphoric acid and magnesium hydroxide in commercial samples using titrimetric methods. CO4: Estimate amount of iodine in tincture iodine sample using volumetric analysis and calculate percentage composition. CO5: Estimate quantity of ibuprofen using back titration method and calculate percentage purity. CO6: Estimate metal ions such as Zn and Ca in pharmaceutical samples using complexometric titration with EDTA.
9	Modules: (Minimum 10 experiments to be performed) Module 1: To prepare - 1) Benzil from Benzoin. 2) 5-nitrosalicylic acid from salicylic acid. 3) Nerolin from 2-naphthol. 4) Benzal acetophenone (chalcone) by condensation of benzaldehyde with acetophenone. 5) p-nitrobenzoic acid from p-nitrobenzaldehyde. 6) Copper sulphate pentahydrate Module 2: To determine - 1) Phosphoric acid from a given sample using 1-naphtholphthalein and phenolphthalein indicator. (Students to prepare succinic acid solution for standardization of NaOH). 2) Magnesium hydroxide in a commercial sample of milk of magnesia. To estimate- 1) Tincture iodine from commercial sample. 2) Ibuprofen in the given sample (Back titration method)

	3) Zn by complexometric titration from the given tablet 4) Ca by EDTA method (titrimetric) from the given tablet.	
10	Reference Books: 1. A. I. Vogel , A Textbook of quantitative Inorganic Analysis Including Elementary Instrumental Analysis, Jhon Wiley and Sons Inc. 3rd edition 1961. 2. N.K. Vishnoi, Advanced Practical Organic Chemistry 3rd Edition, Vikas Publication, 2009. 3. F. G. Mann and B. C. Saunders, Practical Organic Chemistry, Longman Group Limited, 1960. 4. G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denny, Vogel's Textbook of Quantitative Chemical Analysis, Longman Scientific and Technical, 5th Edition, 1989. 5. G. Sevhlá, Vogel's Textbook of macro and semi micro Qualitative Inorganic Analysis, Longman Group Limited, 5th Edition, 1979. 6. A. I. Vogel , A Textbook of quantitative Inorganic Analysis Including Elementary Instrumental Analysis, Jhon Wiley and Sons Inc. 3rd edition 1961.	
11	Internal Continuous Assessment: 40%	External, Semester End Examination 60% Individual Passing in Internal and External Examination
12	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, creative writing, assignment (any 2)	

SEM VI
Vertical – 1
Electives
(2+2)

Title of Paper: Heavy and Fine Chemicals - II

Sr. No.	Heading	Particulars
1	Description of the course : Including but Not limited to :	Heavy and Fine Chemicals – II provides knowledge of industrial processes, materials and technologies involved in manufacture of important heavy and fine chemicals. The course covers industrial reactors, glass manufacturing, production of major chemicals such as sulphuric acid, ammonia and sodium hydroxide, and preparation of inorganic fine chemicals. It also introduces zeolites, ion-exchange resins, composite materials, energy systems, refrigeration, oils, fats and detergents, along with basic concepts of small-scale industries, research and development, intellectual property rights and dye intermediates. Emphasis is placed on understanding industrial processes, material properties, technological developments and their relevance to chemical, pharmaceutical and allied industries.
2	Vertical :	Major (Elective)
3	Type :	Theory
4	Credit:	2 credits
5	Hours Allotted :	30 Hours
6	Marks Allotted:	50 Marks
7	Course Objectives: The course aims to: COB1: Develop understanding of industrial vessels, reactors and materials used in chemical industries. COB2: Provide knowledge of manufacturing processes of important heavy chemicals such as sulphuric acid, ammonia and sodium hydroxide. COB3: Impart understanding of properties and applications of materials such as glass, zeolites, clays, ion-exchange resins and composite materials. COB4: Introduce concepts of small-scale industries, research and development, technology transfer and intellectual property rights.	

	COB5: Provide knowledge of industrial utilities such as energy sources, refrigeration systems, oils, fats and detergents. COB6: Develop understanding of synthesis and applications of dye intermediates and fine chemicals in industry.
8	Course Outcomes: At the end of the course, students will be able to: CO1: Classify industrial reactors, pressure vessels and storage vessels based on their functions in chemical processes. CO2: Explain manufacturing processes of sulphuric acid, ammonia and sodium hydroxide with reference to raw materials, reactions and applications. CO3: Describe properties and industrial applications of glass, zeolites, ion-exchange resins and composite materials. CO4: Explain role of small-scale industries, R&D, technology transfer and intellectual property rights in chemical industry. CO5: Describe principles and applications of energy sources, refrigeration systems, oils, fats and detergents used in industries. CO6: Explain synthesis and uses of selected dye intermediates and fine chemicals relevant to industrial applications.
9	Modules: Module 1: 1.1 Introduction to industrial vessels (2 Hours) Classification of chemical reactors, pressure vessels for internal or external pressure, maintenance, storage vessels for liquids and gases. 1.2 Glass (2 Hours) Composition, types and applications (soda-lime, borosilicate, optical); float glass process. 1.3 Manufacturing process and applications (4 Hours) 1.3.1 Sulphuric acid - Contact Process: raw materials, roasting, double absorption, V_2O_5 catalyst, pollution control, oleum; applications (fertilizers, batteries, pickling, explosives). 1.3.2 Ammonia - Haber Process, applications of ammonia. 1.3.3. Sodium Hydroxide- Chlor-Alkali Process: brine electrolysis, diaphragm/mercury/membrane cell comparison; co-production of Cl_2; caustic soda grades. 1.4 Zeolites, Clays and Ion-exchange resins (2 Hours) Structures, properties, industrial applications (water softening, catalysis, pharma purification). Nano-zeolites: improved catalytic properties, enhanced drug loading capacity.

1.5 Industrial preparation of Inorganic Fine chemicals (2 Hours)1.5.1. KMnO_4 1.5.2. $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ **1.6 Composite materials (3 Hours)**

Introduction, Constitution, Classification and applications of the following –

1.6.1. Particle Reinforced composites, Fiber reinforced composites GFRP/CFRP, Structural Composites or Layered composites,

1.6.2. Nano composites: polymer-clay (montmorillonite), carbon nanotube reinforced polymers - properties and applications.

Module 2:**2.1 Small scale industries, R & D and technology transfer (5 Hours)**

2.1.1 Introduction- Industry Structure.

2.1.2 Need and scope of small scale industry, SSI rules and regulations.

2.1.3 R and D, technology transfer, Role of R and D, Functional structure of R and D unit, Research strategies and manufacturing interface, University-Industry interface,

2.1.4 IPR- Patents, Trade Mark

2.2 General idea of the following (4 Hours)

2.2.1 Energy sources and boilers in Industries:

2.2.2 Refrigeration: System, media used for cold transfer (i.e. brine and other)

2.2.3 Different Sources of Energy: Generation, Treatment of boiler feed water, Properties of steam, steam table Boilers

2.3 Oils and Fats (2 Hours)

2.3.1 Introduction, Classification, Properties of oils and fats.

2.3.2 Extraction of oils from oil seeds, hydraulic pressing and solvent extraction, extraction of animal fats.

2.3.3 Hardening of oils.

2.4 Detergents (2 Hours)

2.4.1. Introduction, Classification- cationic, anionic, nonionic, amphoteric.

2.4.2. Manufacture of DDBS, Industrial applications, Biodegradability issue, Bio-based surfactants

2.5 Introduction to dyes and dye intermediates (2 Hours)

2.5.1 Definition, types of dyes, properties.

2.5.2 Synthesis and uses of the following dye intermediates and dyes: i) Nitro derivatives of benzene and naphthalene ii) Indigo iii) Congo red

10**Reference Books**

- 1 C. D. Dryden: Outlines of Chemical Technology, edited & revised by M. Gopala Rao & Marshall Sittig, East West Press, New Delhi.2008.

	2 Faith Keyes and Clerk's Industrial Chemicals, Wiley Inter-science, 4th Edn., 1975. 3 A. S. Foust, L. A. Wenzel, C. W. Clump, L. Maus and L. B. Anderson, Principles of Unit Operations, John Wiley & Sons. 2nd edition, 2008. 4 W.L. McCabe, J. C. Smith and P. Harriott. Unit Operations of Chemical Engineering, McGraw- Hill International Edition, 7th edition, 2005. 5 P. H. Groggins: Unit Processes in Organic Synthesis, McGraw Hill., 1938. 6 Kirk & Othmer: Encyclopaedia of Chemical Technology, John Wiley and sons.1978. 7 Büchner, Schliebs, and Winter translated by David R. Terrell, Industrial Inorganic Chemistry Wiley-VCH, publisher, New York., 2nd edition, 2000. 8 K. Welssermel, H. J. Arpe, Industrial Organic Chemistry, VCH Publishers, New York. 1997. 9 B. Pearson- Speciality Chemical Innovations in Industrial Synthesis and applications, Kluwer Academic Publishers, 1991. 10 K. Venkatraman, The Chemistry of Synthetic Dyes, Academic press Inc. London, vol.1, 1952. 11 B. K. Sharma, Industrial Chemistry Goyal publishing house, Meerut, 2000. 12 James A. Kent, Riegel's Hand Book of Industrial Chemistry, Springer Nature Link, 9th Edition, 1992. 13 E. Stocchi, Industrial Chemistry, Ellis Horwood Ltd. UK, Vol- I, 1990. 14 Wiseman and Peter, An Introduction to Industrial Organic Chemistry,: Wiley Interscience, New York,1972. Peter Pollak, Fine Chemicals, The Industry and The Business, A John Wiley & Sons, Inc., Publication, Second Edition, 2011. 16 Peter Bamfield, Research and Development in The Chemical and Pharmaceutical Industry By Third Completely Revised And Enlarged Edition, Publication WILEY-VCH Verlag Gmbh & Co. Kgaa, Weinheim 2006 17 Anna Regini Anthony, Overview of Bulk and Fine Chemicals by Walnutpublication.com , 2021.	
11	Internal Continuous Assessment: 40%	External, Semester End Examination 60% Individual Passing in Internal and External Examination
12	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, creative writing, assignment (any 2)	

Title of Paper: Practicals in Heavy and Fine Chemicals - II

Sr. No.	Heading	Particulars
1	Description of the course : Including but Not limited to :	Practicals in Heavy and Fine Chemicals – II provides hands-on training in synthesis and quantitative analysis of chemicals relevant to heavy and fine chemical industries. The course develops practical skills in preparation of organic compounds, dyes and inorganic salts, and determination of physicochemical parameters such as saponification value, iodine value and free fatty acid content of oils and fats. It also includes estimation of organic compounds and metal ions using titrimetric and complexometric methods. Emphasis is placed on experimental accuracy, stoichiometric calculations, determination of percentage yield and application of laboratory techniques relevant to industrial and pharmaceutical chemistry.
2	Vertical :	Major (Elective)
3	Type :	Practicals
4	Credit:	2 credits
5	Hours Allotted :	60 Hours
6	Marks Allotted:	50 Marks
7	Course Objectives The course aims to: COB1: Develop practical skills in synthesis of organic compounds, dyes and inorganic salts relevant to heavy and fine chemical industries. COB2: Understand reaction principles involved in preparation of intermediates used in industrial chemistry. COB3: Gain knowledge of determination of physicochemical properties of oils and fats such as saponification value, iodine value and free fatty acids.	

	COB4: Develop skills in quantitative estimation of organic compounds using hydrolysis methods. COB5: Acquire training in estimation of metal ions using redox and complexometric titration techniques. COB6: Develop competence in calculation of percentage yield and quantitative results from experimental data.
8	Course Outcomes: At the end of the course, students will be able to: CO1: Synthesize compounds such as Orange II, Malachite Green, phthalimide, anthranilic acid and ammonium ferric sulfate and calculate percentage yield. CO2: Determine saponification value of the given sample using titrimetric method and calculate the result. CO3: Determine iodine value and percentage free fatty acids of the given sample using standard titration procedures. CO4: Estimate amount of acetamide using hydrolysis method and calculate percentage composition. CO5: Determine concentration of Fe(II) using KMnO_4 titration and calculate quantitative result. CO6: Estimate copper content using EDTA complexometric titration and calculate concentration of Cu^{2+} ions.
9	Modules: (Minimum 10 experiments to be performed) Module 1: To prepare - 1) Orange II from sulphanilic acid. 2) Malachite Green from benzaldehyde and N,N-dimethylaniline 4) Phthalimide from Phthalic anhydride. 5) Anthranilic acid from phthaliamide 6) Ammonium ferric sulfate Module 2: To determine - 1) Saponification value of a given sample 2) % Free Fatty Acids of a given sample 3) Iodine Value of a given sample To estimate- 1) Acetamide by hydrolysis. 2) Fe(II) by KMnO_4 method (titrimetric) 3) Cu by EDTA method (titrimetric)

10	Reference Books: 1 <u>A. I. Vogel</u> , A Textbook of quantitative Inorganic Analysis Including Elementry Instrumental Analysis, Jhon Wiley and Sons Inc. 3rd edition 1961. 2 N.K. Vishnoi, Advanced Practical Organic Chemistry 3rd Edition, Vikas Publication, 2009. 3 F. G. Mann and B. C. Saunders, Practical Organic Chemistry, Longman Group Limited, 1960. 4 G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denny, Vogel's Textbook of Quantitative Chemical Analysis, Longman Scientific and Technical, 5th Edition, 1989. 5 G. Sevhla, Vogel's Textbook of macro and semi micro Qualitative Inorganic Analysis, Longman Group Limited, 5th Edition, 1979.		
11	<table border="1"> <tr> <td> Internal Continuous Assessment: 40% </td><td> External, Semester End Examination 60% Individual Passing in Internal and External Examination </td></tr> </table>	Internal Continuous Assessment: 40%	External, Semester End Examination 60% Individual Passing in Internal and External Examination
Internal Continuous Assessment: 40%	External, Semester End Examination 60% Individual Passing in Internal and External Examination		
12	<table border="1"> <tr> <td> Continuous Evaluation through: Quizzes, Class Tests, presentation, project, creative writing, assignment (any 2) </td><td></td></tr> </table>	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, creative writing, assignment (any 2)	
Continuous Evaluation through: Quizzes, Class Tests, presentation, project, creative writing, assignment (any 2)			

QUESTION PAPER PATTERN (External)

Time: 1 Hour

Marks: 30

N.B.:

1. All Questions are Compulsory.
2. Draw neat and labelled diagrams wherever necessary.

Q. No	Type	Marks	Module
Q.1	Multiple Choice Question / Fill in the Blanks (Any 5 out of 10) (5 from each Module)	5	1 & 2
Q.2	Answer in 1–2 Sentences: (Any 5 out of 10) (5 from each Module)	5	1 & 2
Q.3	Answer any 2 of the following. (Any 2 out of 4)	10	1
Q.4	Answer any 2 of the following. (Any 2 out of 4)	10	2

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 - 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0