

 <p>Estd. 1962 "A" Accredited by NAAC(2021) With CGPA 3.52</p>	<p align="center">SHIVAJI UNIVERSITY, KOLHAPUR - 416 004, MAHARASHTRA</p> <p align="center">PHONE : EPABX – 2609000, www.unishivaji.ac.in, bos@unishivaji.ac.in</p> <p align="center">शिवाजी विद्यापीठ, लिहापूर - ४१६ ००४, महाराष्ट्र</p> <p align="center">दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दूरध्वनी विभाग ०२३१-२६०९०९३/९४</p>	
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SU/BOS/Sci & Tech/

No 00391

Date : 18/08/2022

18 AUG 2022

To,

The Principal/ Director,

All affiliated Engineering Colleges/ Institute,
Shivaji University, Kolhapur.

Subject: Regarding revised syllabus of Ph. D. Coursework of Chemical Engineering under the Faculty of Science and Technology.

Sir/Madam,

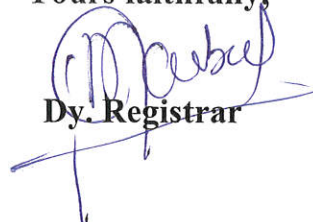
With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the syllabus of **Ph. D. Coursework of Chemical Engineering** under the Faculty of Science and Technology.

This syllabus will be implemented from the academic year 2022-23 i.e. from June 2022 onwards.

You are therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,



Dy. Registrar

Copy to:

1	The I/c Dean Faculty of Science & Technology	6	Appointment Section
2	The Chairman, Respective Board of Studies	7	Affiliation Section (T.1)
3	Director, Examination and Evaluation	8	Affiliation Section (T.2)
4	Eligibility Section	9	P.G.Admission Section
5	O.E. – 4	10	P.G Seminar Section



SHIVAJI UNIVERSITY, KOLHAPUR

Course Work Syllabus

For

Ph.D.

IN CHEMICAL ENGINEERING-2022-23

Ph.D. COURSE WORK: Theory paper III

(OPTIONAL PAPERS BASED ON SPECIALISATION: Any one OUT OF 12 PAPERS)

Lectures: 3 Hrs./Week

Theory: 80Marks

Tutorial: 1 hrs/week

Term Work:

20 Marks

Electives List:

- 1. Recent Trends in Food Process Engineering: Food processing methods:** general processing methods for various food products - soft and alcoholic beverages, dairy products, meat, poultry and fish products. Treatment and disposal of food processing wastes., **Separation processes in food processing:** Electro-dialysis Systems, Membrane Systems, Reverse-Osmosis and Ultra filtration Systems, Drying Processes, Dehydration System, Sedimentation, Centrifugation and Mixing. **Food preservation methods:** Preservation by heat and cold, dehydration, concentration, drying irradiation, microwave heating, sterilization and pasteurization, fermentation and pickling., **Packaging:** Introduction, Food Protection, Product Containment, Product Communication, Product Convenience, Mass Transfer in Packaging Materials. Innovations in Food Packaging, Product Shelf-life. Food canning technology-fundamentals. Heat sterilization of canned food, containers - metal, glass and flexible packaging. Canning procedures for fruits, vegetables, meats, poultry and marine products.
- 2. Recent trends in Surface Coating Industry:** Review on Surface Coating Technologies. Types of Surface Coatings, their applications. Recent developments in each of the types of surface coatings as well as their applications. Challenges and scope of the industry.
- 3. Advanced Instrumental Method of Chemical Analysis:** Constructions, working Principle and applications of UV visible Spectrophotometer, Gas chromatography, High Performance Liquid chromatography, FTIR Spectrophotometer, Gel Permeation chromatography, Working Principle, construction & Applications of Scanning Electron Microscope, Transmission Electron Microscope, X-Ray Diffraction Spectrophotometer, Atomic Force Microscope, Particle size analyzer.
- 4. Advanced Biochemical Engineering:** Review of Biochemical processes, Microbial biochemistry: Fermentation technology, Biofuel Technology, pyrolysis and gasification of biomass, design aspects of

bioreactors, Use of Microbes modeling of biochemical reaction and applications to scale up. Metabolic pathways and Bioreactor models.

5. **Advanced Waste Water Treatment:** Sources and characterization of water pollution, Primary Treatment: gravity separator, equalization tanks, Sedimentation, Flotation Secondary Treatment – Design of: Up flow Anaerobic, Sludge Blanket (USAB) reactor, Activated Sludge process – Rotating Biological Contactors (RBC), Trickling Filters; Natural Treatment - Wetland Systems, Waste Stabilization Ponds. Tertiary Treatment systems: Disinfection etc. Sludge and solid wastes treatment: Identification of hazardous wastes – disposal and waste minimization, waste management.
6. **Basics of Nanoscience and Nanotechnology:** Overview of Nanoscience: Important concepts such as size, quantum effect, Moore's law, and etc Synthesis of nanomaterials (chemical routes, thermolysis routes, etc.), Properties (Electrical, optical and mechanical) at nano-scale. – Characterization techniques: Beam probe methods (SEM, TEM, EDX, X-ray scattering), Scanning probe methods (STM and AFM), and other techniques (Optical spectroscopy, Chromatography, Light scattering). Nanotechnology: Various Approaches (Top-down, Bottom-up, Self-assembly, self-organization), Nano engineering (Physics and Chemistry of surfaces), Interface between Physics, Chemistry and Biology, Nano fluidics and Nano electronics, Bio-sensors, Drug delivery, Tissue Engineering.
7. **Artificial Intelligence in Chemical Engineering:** Artificial intelligence: Role in chemical engineering. Knowledge representation; Heuristic knowledge; Rule-based knowledge; Decision trees; object-oriented programming. Artificial neural networks: Pattern recognition; Classification; Process optimization. Data mining: Windowing techniques; Wavelet transforms- noise, filtering, pattern recognition. Uncertainty: Fuzzy logic- definition; possibility theory; fuzzy numbers and fuzzy arithmetic; Genetic algorithm; Simulated annealing. Expert Systems: Knowledge based systems; Fuzzy expert systems; Building and expert systems Applications of AI in Chemical Processes.
8. **Fuel Cell Technology:** Overview of fuel cells: Introduction to fuel cells and their characteristics – Classification Low and high temperature fuel cells. Module-2 Fuel cell thermodynamics: Heat, work potentials, prediction of reversible voltage, fuel cell efficiency. Module-3 Fuel cell reaction kinetics: Electrode kinetics, over voltages, Tafel equation, charge transfer reaction, exchange currents, electro-catalyses - design, activation kinetics, Fuel cell charge and mass

transport - flow field, transport in electrode and electrolyte. Module-4 Fuel cell characterization: In-situ and ex-situ characterization, techniques, i-V curve, frequency response analyses; Fuel cell. Module-5 Balance of plant: Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.

9. **Air Pollution Control Engineering:** Introduction, Definition, Sources, Characteristics and Perspective of Air Pollutants, Effects of Air Pollution on Biodiversity, Economic Effects of Air Pollution, Air Quality and Emission Standards, Engineering Systems of Control of Air Pollution by Equipment and by Process Changes, Air Pollution from Major Industrial Operations, Air pollution legislation and regulations. Case studies of a few industrial pollution control systems.
10. **Process Integration Techniques: The nature of Chemical Process Design and Integration:** Formulation, Hierarchy, approaches. Thermodynamic properties and phase equilibria: Equations of state, Fugacity, VLE, LLE, Calculation of enthalpy, entropy, simple problems. , **Energy targets:** Composite curves, Temperature interval diagram, process constraints, Grand composite curve, simple Problems. **Network design:** Pinch design method. Minimum no of heat exchangers, breaking of heat loop, Stream splitting, No. of heat exchanger units, heat exchange area targets Simple problems. **Mass exchangers:** types, cost optimization of mass exchangers, Mass integration strategies, Mass exchange Pinch diagram, Composition interval diagram, simple problems. Application of process integration concepts in minimum water usage, pinch technology for wastewater treatment applications, simple problems.
11. **Renewable Energy and Alternative Fuels:** Introduction to energy and resources – Renewable energy sources, Biomass to energy conversion processes- Anaerobic digestion, process parameters, biogas composition, digester types, high rate anaerobic conversion systems- Alcohol from biomass – Biodiesel: preparation, characteristics and application - Biomass combustion and power generation – Briquetting-Gasification: Process, types of gasifiers, applications - Waste to energy technologies , Fossil fuels and their availability - Potential alternative liquid and gaseous fuels- Merits and demerits of various alternative fuels , Various vegetable oils- Properties- Esterification- Performance and emission characteristics - Bio-diesel: Feed stock, characteristics, preparation (lab and commercial), storage, applications, environmental impacts, economics, policy.

12. Recent Trends in Oil, Fermentation & Pharmaceutical Industry:
Oil- Enzymatic fat splitting and Transesterification Edible Oil Refining – Alkali Refining, Physical Refining
Fermentation Technology- Production of wine, Beer, Industrial Alcohol, Citric Acid, yeast, Distilled Alcoholic Beverages, Oriental Fermented Soya food,
Pharmaceutical Formulations (Solid dosage) - Novel Drug Delivery System (NDDS): Factors to be considered in design Controlled release drug delivery (CRDD), Effects of system parameters, Classification of CRDD, Application, Advantages and disadvantages

Elective wise Reference Books:

1. i) Food Science B Srilakshmi New Age 2003
 ii) Introduction to Food Science Rick Parker Delmar/Thomson Learning 2003
 iii) Food Processing and Preservation G.Subbulakshmi and Shobha A. Udipi New Age 2001
 iv) “Fundamentals of Food Process Engineering” by Romeo T Toledo
2. i) Organic Coating- Science and Technology, Third Edition (2007)- Wicks, W., Jones, F. N., Pappas,
 ii) “Introduction to Paint Technology” by CIS
 iii) “Surface Coatings: Vol I-Raw Materials and Their Usage: 1” by Oil and Colour Chemists Association of Australia St
 iv) “Surface Coatings for Advanced Materials (Materials Science Forum)” by R P Agarwala
 v) Matthews, A., Advanced Surface Coatings: a Handbook of Surface Engineering, Editors: Rickerby, David (Ed.)
 vi) NPCS Board of Consultants & Engineers, Surface Coating Technology Handbook, Asia Pacific Business Press Inc.
3. i) Instrumental analysis by Skoog, & Holler.
 ii) Instrumental methods of analysis by Willard
 iii) “Principles of Instrumental Analysis” by D Skoog
4. i) M.L. Shuler and F. Kargi, "Bioprocess engineering", 2nd Edition, Prentice Hall of India, New Delhi. 2002.

- ii) J. E. Bailey and D.F. Ollis, "Biochemical Engineering Fundamentals", 2nd Ed., McGraw-Hill Publishing Co. New York. 1986.
- iii) Biochemical engineering fundamentals, by James, E. Bailey and David F Olli's, II Edition, McGraw-Hill Internal Edition, 1986
- 5. i) S.J. Arceivala, Wastewater Treatment and Disposal, marcel Dekker, 1981.
- ii) Metcalf and Eddy, Wastewater Engineering, Treatment, Disposal and Reuse, Inc. Third edition McGraw – hill, 1991.
- iii) Nicholas P. Cheremisinoff, Handbook of Water and Wastewater Treatment Technologies, Butterworth-Heinemann Publications, N&P Limited, Boston Oxford Auckland Johannesburg Melbourne New Delhi.
- 6. i) Introduction to Nanotechnology Charles P. Poole Jr and Frank J. Owens Wiley 2003
- ii) Nano: The essentials: Understanding nanoscience and nanotechnology T. Pradeep Tata McGrawHill 2008
- iii) Nanomaterials Chemistry Rao C. N., A. Muller, A. K. Cheetham Wiley 2007
- iv) Handbook of Nanoscopy Dirk van Dyck, Gustaaf van Tendeloo, Stephen J. Pennycook Wiley 2012
- v) Joydeep Dutta, Harry F. Tibbals and Anil K. Rao,, Introduction to Nano Science, CRC Press G. Louis Hornyak, 2009
- vi) R. Kelsall, I. Hamley and M. Geoghegan (Eds.), "Nano scale Science and Technology", Wiley, 2005
- 7. i) "Problem Solving Methods in Artificial Intelligence" by N L Nilsson
- ii) "Artificial Intelligence in Chemical Engineering" by T E Quantrille and Y A Liu
- iii) "Introduction to Artificial Neural Systems" by J Zuarda
- iv) "Intelligent Systems in Process Engineering" by G Stephanopoulos and V Venkatasubramanian
- 8. i) Fuel Cell Fundamentals Ryan O'Hayre, SukWon Cha, Whitney Colella, Fritz B. Prinz Wiley & Sons 2006
- ii) Electrochemical Methods Allen J. Bard, Larry R. Faulkner John Wiley & Sons 2000
- iii) Recent Trends in Fuel Cell Science and Technology S. Basu Springer 2007
- iv) Principles of fuel cells Liu, H Taylor & Francis 2006

9. i) Environmental Pollution Control Engineering C S Rao New Age International 2010
- ii) Principles and Practices of Air Pollution Control and Analysis J. R. Mudakavi I.K. International Publishing House Pvt. Limited 2010
- iii) Air Pollution control theory Martin Crawford Tata McGrawHill 1980
- iv) Air Pollution Part A&B Joe Ledbetter Marcel Dekker 1972
- v) Air Pollution Control Design Hand Book Part I and II Paul N. Cheremisinoff, Richard Alan Young M. Dekker 1977
- 10.i) Chemical Process Design & Integration Robin Smith Wiley 2005
- ii) Process Integration Mahmoud. M., El – Hawalgi Academic Press 2006
- iii) A User Guide on Process Integration for Efficient Use of Energy Bodo Linnhoff Institution of Chemical Engineers 1982
- iv) Pinch Analysis and Process Integration - A user guide on process integration for efficient use of energy Ian C. Kemp Elsevier Science 2011
- 11.i) Handbook of Energy Efficiency and Renewable Energy Frank Kreith and D.YogiGoswami CRC Press 2007
- ii) Renewable Energy Resources John Twidell and Tony Weir Taylor & Francis 2006
- ii) Solar Engineering of Thermal Process John A. Duffie and William A. Beckman John Wiley & Sons 2006
- iv) Renewable and Efficient Electric Power Systems Gilbert M. Masters Wiley Interscience 2004
- v) Present and Future Automotive Fuels Osamu Hirao and Richard Pefley Wiley Interscience 1988
- 12.i) Bailey's Industrial Oils and fats- Vol. 1-6 (2005)
- ii) Principles of Fermentation Technology Peter F. Stanbury, Allan Whitaker, Stephen J Hall Elsevier Science 1995
- iii) Michel Deleers, Nanoparticulate drug delivery systems.
- iv) Jean – Maurice Vergnaud, Controlled drug release of oral dosage form.
- v) Philip J. Breen, Basic Pharmacokinetics.
- vi) Novel drug delivery systems by Yie W. Chien.
- vii) Biopharmaceutics and Pharmacokinetics by Brahmankar