# Chemical and Biochemical Engineering

| Semester IV | | | | | | |
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| **S.No** | **Course Code** | **Course Name** | **L** | **T** | **P** | **C** |
| **1** | CS204T | Artificial Intelligence | 3 | 0 | 0 | 6 |
| **2** | CS201L | Artificial Intelligence Lab | 0 | 0 | 3 | 3 |
| **3** | CH206T | Materials Science for Chemical Engineers | 3 | 0 | 0 | 6 |
| **4** | BB403T | Biophysics | 3 | 0 | 0 | 3 |
| **5** | BB201L | Biology Lab I | 0 | 0 | 3 | 3 |
| **6** | CH201L | Chemical Engineering lab -1 (Thermodynamics and fluid mechanics) | 0 | 0 | 3 | 3 |
| **7** | CL201T | Reaction engineering | 3 | 0 | 0 | 6 |
| **8** | CH202T | Mass transfer | 3 | 0 | 0 | 6 |
| | | **Total Credits** | | | | **36** |

# Chemical and Biochemical Engineering

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| **1** | **Title of the course** (L-T-P-C) | **Artificial Intelligence** **(3-0-0-6)** |
| **2** | **Pre-requisite courses(s)** | |
| **3** | **Course content** | Search: Problem representation; State Space Search; A* Algorithm and its Properties; AO* search, Minimax and alpha- beta pruning, AI in games. Logic: Formal Systems; Notion of Proof, Decidability, Soundness, Consistency and Completeness; Predicate Calculus (PC), Resolution Refutation, Herbrand Interpretation, Prolog. Knowledge Representation: PC based Knowledge Representation, Intelligent Question Answering, Semantic Net, Frames, Script, Conceptual Dependency, Ontologies, Basics of Semantic Web. Leaning: Learning from Examples, Decision Trees, Neural Nets, Hidden Markov Models, Reinforcement Learning, Learnability Theory. Uncertainty: Formal and Empirical approaches including Bayesian Theory, Fuzzy Logic, Non-monotonic Logic, Default Reasoning. Planning: Blocks World, STRIPS, Constraint Satisfaction, Basics of Probabilistic Planning.<br>Advanced Topics: Introduction to topics like Computer ain |
| **4** | **Texts/References** | Text: Stuart J. Russel, Peter Norvig, Artificial Intelligence: A Modern Approach (3rd ed.). Upper Saddle River: Prentice Hall, 2010. Other references: N.J. Nilsson, Principles of Artificial Intelligence, Morgan Kaufmann, 1985. Malik Ghallab, Dana Nau, Paolo Traverso, Automated Planning: Theory & Practice, The Morgan Kaufmann Series in Artificial Intelligence, 2004. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2006. Mark Stefik, Introduction to Knowledge Systems, Morgan Kaufmann, 1995. E. Rich and K.Knight, Artificial Intelligence, Tata McGraw Hill, 1992. |

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| **1** | **Title of the course** (L-T-P-C) | **Artificial Intelligence Lab** **(0-0-3-3)** |
| **2** | **Pre-requisite courses(s)** | |
| **3** | **Course content** | The lab will closely follow and aim to elucidate the lessons covered in the theory course CS344. Implementation and study of A*, Usage of Prolog Inferencing, Expert System Shells, Neural Net Platforms, Prediction and Sequence Labeling using HMMs, Simulation of Robot Navigation and such exercises are strongly recommended. |
| **4** | **Texts/References** | Stuart J. Russel, Peter Norvig, Artificial Intelligence: A Modern Approach (3rd ed.). Upper Saddle River: Prentice Hall, 2010. Other references: N.J. Nilsson, Principles of Artificial Intelligence, Morgan Kaufmann, 1985. Malik Ghallab, Dana Nau, Paolo Traverso, Automated Planning: Theory & Practice, The Morgan Kaufmann Series in Artificial Intelligence, 2004. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2006. Mark Stefik, Introduction to Knowledge Systems, Morgan Kaufmann, 1995. E. Rich and K.Knight, Artificial Intelligence, Tata McGraw Hill, 1992. |

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| **1** | **Title of the course** (L-T-P-C) | **Materials Science for Chemical Engineers**<br>**3-0-0-6** |
| **2** | **Pre-requisite courses(s)** | -- |
| **3** | **Course content** | **Introduction:** Introduction to materials and their principle properties, Atomic bonding, crystal structure and defects, Basic principles in their selection for fabrication and erection of the chemical plant.<br><br>**Deformation:** Plastic deformation - Mechanism of plastic deformation, slip, work hardening, deformation in polycrystalline materials, Effect of cold working and annealing, hot working. Elastic deformation, Anelastic deformation, Viscoelastic deformation – models for viscoelastic behavior.<br><br>**Fracture:** Types of fracture, cleavage, brittle, ductile, Griffith crack theory, Theories of crack initiation, ductile-brittle transition.<br><br>**Testing of materials**: Destructive tests - Tensile testing, stress-strain curves, condition for necking, compression testing, Hardness testing. Creep-testing method, creep curve, requirements for creep resistance materials. Fatigue – testing method fatigue prevention. Non-destructive tests. Thermal properties: Heat capacity and specific heat, Thermal expansion, thermal conductivity, thermal shock.<br><br>Heat treatment: Annealing, quenching, normalizing, hardening, martempering, Aus tempering, case hardening, cyaniding, nitriding, flame hardening, induction hardening, diffusion coating, furnaces, and temperatures.<br><br>Phase diagram: Basic terms, Hume - Rothery rules of solid solubility, Gibb's phase rule, polymorphism, solidification of pure metal. Types of cooling curves, plotting of equilibrium diagram, lever rule, common types of phase diagram, other transformations in alloy system; Non-equilibrium cooling. |
| **4** | **Texts/References** | **1.** William D. Callister Jr., David G. Rethwisch. "Materials Science and Engineering: An Introduction", Wiley, 10th Edition, January 2018 ISBN: 978-1-119-40549-8,<br>**2.** James F. Shackelford. "Introduction to Materials Science for Engineers", Pearson College Div; 8th edition, 2 April 2014, ISBN-10 :0133826651<br>**3.** Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright. "The Science and Engineering of Materials". Cl-Engineering; 6th edition (21 June 2010), ISBN-10 : 0495296023<br>**4.** V. Raghavan. "Materials Science and Engineering: A First Course". Prentice Hall India Learning Private Limited; 6th edition (1 January 2015), ISBN-10 9788120350922:<br>**5.** Hajra Choudhury S. K, "Material science and processes", Imprint unknown (1 March 1978), ISBN-10: 0906216001. |

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| **1** | **Title of the course (L-T-P-C)** | **Biophysics (3-0-0-3)** |
| **2** | **Pre-requisite courses(s)** | |
| **3** | **Course content** | • Diffusion and Brownian motion and biological applications.<br>• Electrostatic interactions<br>• Chemical potential and Chemical reactions<br>• Self-assembly, micelles, cell membranes<br>• Helix coil transition<br>• Stretching of macromolecules<br>• Protein folding<br>• Unzipping of DNA<br>• Machines in membranes<br>  ○ Electro-osmotic effects<br>  ○ Ion pumping<br>• Nerve Impulses<br>  ○ Action Potentials<br>  ○ Ion Channels<br>• Physical Techniques and related biology<br>  ○ X-ray diffraction, light and neutron scattering<br>  ○ Nuclear magnetic Resonance<br>  ○ Fluorescence<br>  ○ DNA Microarrays<br>  ○ Manipulation of biomolecules using optical tweezers.<br>  ○ Tomography<br>  ○ Patch clamps |
| **4** | **Texts/References** | 1. Physical biology of the cell, second edition by rob phillips, jane kondev, julie theriot, and hernan garcia (garland science, 2012).<br>2. Biological Physics: energy, information, life student edition by philip nelson. (chiliagon science) |

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| **1** | **Title of the course** (L-T-P-C) | **Biology Lab I**<br>**(0-0-3-3)** |
| **2** | **Pre-requisite courses(s)** | None |
| **3** | **Course content** | **1.** Biological solutions preparation<br>**2.** Titration of amino acids,<br>**3.** Estimations of reducing non-reducing sugars, proteins, DNA, RNA, lipids,<br>**4.** paper chromatography/TLC,<br>**5.** SDS-PAGE, isoelectric focusing,<br>**6.** DNA melting curves<br>**7.** Enzyme assays |
| **4** | **Texts/References** | NA |

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| **1** | **Title of the course** (L-T-P-C) | **Chemical Engineering lab -1 (Thermodynamics and fluid mechanics) (0-0-3-3)** |
| **2** | **Pre-requisite courses(s)** | -- |
| **3** | **Course content** | Thermoynamics: Determination of partial molar enthalpies, vapour pressures, infinite dilution activity coefficient, vapour-liquid equilibrium, adiabatic calorimetry.<br>Fluid mechanics: Flow visualization, Flow rate, velocity and pressure measurements, calibration of flow-meters, flow-through pipes and piping elements including Bernouli's principle, Impact of fluid-jets on substrates. |
| **4** | **Texts/References** | |

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| **1** | **Title of the course** (L-T-P-C) | **Reaction engineering**<br>**(3-0-0-6)** |
| **2** | **Pre-requisite courses(s)** | Nil |
| **3** | **Course content** | Kinetics Reaction rate, order, rate constant; Batch reactors Design + basics; Kinetic constants from batch reactor data; Ideal flow reactors Mass and Energy balances; Isothermal, adiabatic and non-isothermal operation; Catalysts, Catalytic rates, Reaction mechanisms; Internal/External transport in catalysts; Non-catalytic solid-gas reactions; Reactor design for ideal flow reactors; Yield and Selectivity; Concept of RTD; Segregation and Maximum Mixedness models |
| **4** | **Texts/References** | 1.H.S.Fogler, Elements of Chemical Reaction Engineering, 2nd ed., Prentice Hall, New Jersey, 1992.<br>2.O.Levenspiel, Chemical Reaction Engineering, 2nd ed., Wiley Eastern,1992<br>3.J.M.Smith, Chemical Engineering Kinetics, 3rd ed., McGraw Hill, 1980. |

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| **1** | **Title of the course (L-T-P-C)** | **Mass transfer (3-0-0-6)** |
| **2** | **Pre-requisite courses(s)** | **Nill** |
| **3** | **Course content** | Principles of Mass transfer: Constitutive laws of diffusion; unsteady state diffusion; Convective mass transfer. Interphase mass transfer and mass transfer coefficients; Mass transfer theories/models; Equilibrium stages and transfer units: number and height of transfer units; stage efficiency. Gas absorption: plate and packed column design. Distillation: batch distillation, continuous fractionation, other types of distillation (e.g., azeotropic), solvent extraction, drying, cooling towers. |
| **4** | **Texts/References** | 1. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.<br>2. E.D. Cussler, Di usion - Mass Transfer in Fluid Systems, Cambridge University Press, Cambridge 1984.<br>3. A. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.<br>4. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993. |