Scheme of Instructions of III & IV Semesters of
B. TECH (Chemical Engineering) as per
Model Curriculum 2019-20

IN

B. TECH (Chemical Engineering)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
(An Autonomous Institution)
Affiliated to OU; All U.G. and 5 P.G. Programmes (Civil, CSE, ECE, Mech. & EEE)
Accredited by NBA; Accredited by NAAC - 'A' Grade (UGC);
ISO Certified 9001:2015

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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A)
Model Curriculum (with effect from 2019-20)
B. TECH (Chemical Engineering)

SEMESTER – III

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	18MT C 05	Mathematics-III	3	1	-	3	30	70	4
2	18CH C 01	Technology of Surface Coatings and Oils	3	1	-	3	30	70	4
3	18CH C 02	Chemical Engineering Thermodynamics-I	3	1	-	3	30	70	4
4	18CH C 03	Numerical methods in Chemical Engineering	3	1	-	3	30	70	4
5	18CH C 04	Material and Energy Balance computations	3	1	-	3	30	70	4
6	18EG M 01	Indian constitution	2	-	-	2	-	50	Non credit
7	18EE M 01	Indian traditional knowledge	2	-	-	2	-	50	Non credit
PRACTICALS									
8	18CH C 05	Numerical methods in Chemical Engineering Lab	-	-	2	2	15	35	1
9	18CH C 06	Technology of Surface Coatings and Oils Lab	-	-	2	2	15	35	1
Total			**19**	**05**	**4**	-	**180**	**520**	**22**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE - Semester End Examination

18MT C 05

MATHEMATICS-III

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: This course helps the students to understand the

1. To form PDE and to find its solution.
2. To solve wave and heat equations.
3. To learn the Laplace and Inverse Laplace transforms for solving engineering problems.
4. To learn Fourier transform and Z-transforms for solving engineering problems.
5. Learning the basic concepts of probability and Statistical Analysis.

Course Outcomes: At the end of the course, the students will be able to

1. Solve Linear and Non-Linear PDE's.
2. Solve One-Dimension Wave and Heat equations and Two Dimension Laplace equation.
3. Find Laplace transform and inverse Laplace transform and can solve Linear Differential equations.
4. Find the solutions of various Transforms.
5. Find moments of discrete and continuous random variables as well as familiar with distribution.

UNIT-I: Partial Differential Equations

Formation of Partial Differential Equations, Solution of First Order Linear Partial Differential Equations by Lagrange's Method, Solution of First Order Non-linear Partial Differential Equation by Standard types and Charpits Method.

UNIT-II: Applications of Partial Differential Equation

Solution by Method of Separation of Variables, Solution of One dimensional Wave equation, One dimensional Heat equation, Two dimensional Laplace equation and its related problems.

UNIT-III: Laplace Transform

Laplace Transform of standard functions, Linearity property, change of scale property. Shifting theorems, Laplace Transform of Periodic Function, Unit step function and Unit impulse function. Transforms of derivatives, Transforms of

integrals, Multiplication by t^n and division by t. Inverse Laplace Transform properties, Inverse Laplace Transform by partial fractions and Convolution theorem, Applications of Laplace Transform (Solution of Linear Differential Equations).

UNIT-IV: Fourier Transforms and Z-Transforms

Fourier Transforms: Fourier integral theorem (statement), Complex form of Fourier integrals. Fourier transforms, Inverse Fourier Transforms, Fourier Sine and Cosine transforms, Inverse Fourier Sine and Cosine Transforms. Properties of Fourier transforms: Linear property, change of scale property, shifting property and Modulation theorem.

Z-Transforms: Z-transforms of standard functions, linearity property, damping rule, shifting theorems, multiplication by 'n', initial and final value theorems. Inverse Z-Transform: Inverse Z-transform by Convolution theorem, partial fractions. Z-transform application to difference equations.

UNIT-V: Basic Statistics

Random variable, discrete probability distribution and continuous probability distribution. Expectation, Addition theorem and Multiplication theorem of expectation, properties of variance, Poisson distribution (Mean, variance, MGF & CGF), Normal distribution (Mean, variance, MGF & CGF), Properties of Normal distribution, Areas of under normal curve. Correlation and regression.

Text Books:

1. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 35th Edition, 2000.
3. Sheldon Ross, "A First Course in Probability", 9th Edition, Pearson publications, 2014.

Suggested Readings:

1. S. J. Farlow, "Partial Differential Equations for Scientists and Engineers", Dover Publications, 1993.
2. Ian Snedon, "Elements of Partial Differential equations", McGraw Hill, 1964.
3. S.C.Gupta, V.K.Kappoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 2014.

18CH C 01

TECHNOLOGY OF SURFACE COATING AND OILS

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: This course helps the students to understand the

1. To give fundamental concepts in paints (including industrial paints and domestic paints)
2. Basic properties, uses of main ingredients like pigments, extenders, binders, solvents.
3. To know more about paint application systems (both air drying paints and stoving paints of liquid paints and power paints).
4. To impart knowledge on special coatings
5. To familiarize about sources, types and composition of oils and fats.

Course Outcomes: At the end of the course, the students will be able to

1. Identify the suitable paints for domestic and Industries.
2. Study more about specific paint manufactures.
3. Know main ingredients of paints, their manufacturers and properties.
4. Analyze the types of special paints and their application
5. Analyze the various properties of fats and oils to determine their use in food, soap and other industries

UNIT-I

Major components of surface coatings. Fundamentals of film formation, Classification of Paints: Air drying paints, stoving paints, their properties and uses. Liquid paints & powder paints, their properties & uses. Pigments: Importance of pigments - their basic properties, uses & their applications. Manufacture of Pigments: Titanium di-oxide, red lead.

UNIT-II

Extenders: Importance, properties & significance. Manufacture of Extenders: Blanc fixe, China clay, Gypsum, Mica & talc. Solvents: Importance, uses & their properties, Manufacture of solvents: Turpentine, Alcohols- Methyl Alcohol, Ethyl Alcohol, n-Propyl Alcohol.

UNIT-III

Manufacture of Paints: Distempers- Manufacture, properties & uses. Powder Paints-Manufacture, properties & uses. Enamel - Manufacture, properties &

uses. Application methods of paints: Air drying paints, industrial liquid stoving paints & industrial stoving powder paints. Brush application, Roller coating, spray application, electrostatic spray application.

UNIT-IV

Special Coatings: Importance, Significance & their applications. Powder Coatings, Water soluble coatings, aluminium coatings, water proof coatings, heat resistant coatings, automobile coatings, fire retardant coatings, space, air craft coatings, swimming pool coatings and Anti Micro growth Paints (Marine Paints).

UNIT-V

Introduction of Oils, Fats & Waxes, essential oils, their sources and composition. Types of Oils, Hydrogenation, Esterification and Interesterification, Saponification, Halogenation.

Text Books:

1. W.M. Morgans, "Outline of Paint Technology", Edward Arnold Publishers, London, 1990
2. R. Lambourne & T A Strivens, "Paint & Surface coatings", Second edition, 1999
3. Ed. D Swern, "Bailey's Industrial Oils and Fats Products", Wiley Inter Science publication, N.Y. John Wiley and Sons ,6th Edition, 2006

Suggested Readings:

1. Patton Temple, "C Pigment Flow & Pigment Dispersion", Wiley Inter science, 1979
2. Swaraj Paul, " Surface Coatings science and technology" , 1995
3. M M Chakrabarty , "Chemistry and Technology of Oils and Fats", Allied Publishers Pvt.Ltd., 1st Edition, 2007
4. O P Narula, "Treatise on fats,Fatty acids and Oleochemicals", Vol I and II, Industrial Consultants (India), 1994

18CH C 02

CHEMICAL ENGINEERING THERMO DYNAMICS-I

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: This course helps the students to understand the

1. Basic thermodynamic laws and principles
2. Concept of energy conservation through the study of the first and second laws of thermodynamics
3. Concept of entropy and its importance in energy conversion
4. Identify, formulate and solve chemical engineering problems involving various types of systems and processes
5. Application of Thermodynamics to flow process

Course Outcomes: At the end of the course, the students will be able to

1. Understand the relation between the measurable nature of P, V, T and the un-measurable nature of H, U, A, G.
2. Use equations of state, correlations and tables for estimation of thermodynamic properties of real gases
3. Understand and analyze processes involving ideal gases, such as isothermal, isobaric, isentropic, cyclic
4. Apply energy balances to open and closed systems and to evaluate the thermodynamic efficiency of nozzles, compressors, turbines
5. Analyze steam power cycles; refrigeration cycles, and liquefaction

UNIT – I The First Law and Other Basic Concepts: Joule's Experiments - Internal Energy - Formulation of the first law of the thermodynamics - the thermodynamic state and state functions - Enthalpy - The steady state flow processes; equilibrium - the phase rule - The Reversible process - Constant V and constant P processes and heat capacity. Volumetric Properties of Pure Fluids: PVT behavior of pure substances, the Ideal gas, virial equations and their use in the calculation of P-V-T Properties; use of Cubic equations of state (Van der Waals and Redlich-Kwong), generalized correlations for gases

UNIT– II Second law of thermodynamics: Statement of the second law, heat engines, thermodynamic temperature scales, thermodynamic temperature and ideal-gas scale, entropy, entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point.

UNIT – III Thermodynamic properties of fluids; Relationships among thermodynamic properties for a homogenous phase of constant composition; Maxwell relations, Residual properties; Two-phase systems. Thermodynamic diagrams; generalized property correlations for gases

UNIT – IV Conversion of Heat into Work by Power Cycles: Steam power plants; Carnot cycles; Rankine cycle; Otto cycle, Diesel cycle
Refrigeration and Liquefaction: the vapor - compression cycle; comparison of Refrigeration cycles; the choice of refrigerant; absorption refrigeration; the heat pump; various processes for liquefaction.

UNIT – V Thermodynamics of Flow Processes: Energy balances for steady state flow process; Application of thermodynamics to flow processes-pumps, compressors and turbines; calculation of ideal work and lost work for flow processes

Text Books:

1. Introduction to Chemical Engineering Thermodynamics (in SI units) by J M Smith and H C Van Ness and M M Abbott, 7th edition, Mc-Graw Hill International Edition, 2005

Suggested Readings:

1. A Textbook of Chemical Engineering Thermodynamics by K.V. Narayanan, PHI Pvt. Ltd., 2001
2. Chemical Engineering Thermodynamics by Y V C Rao, Universities Press, 1997
3. M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engg. Thermodynamics, 8th Edition, Willey, 2018.

18CH C 03

NUMERICAL METHODS IN CHEMICAL ENGINEERING

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	4

Course objectives: This course helps the students to understand the

1. Error analysis for various numerical methods
2. Appropriate numerical methods to solve non-linear algebraic and transcendental equations and linear system of equations
3. Appropriate numerical methods to approximate a function
4. Appropriate numerical methods to solve an ordinary differential equation
5. Various techniques to solve Partial differential equations

Course outcomes: At the end of the course, the students will be able to

1. Perform an error analysis for a given numerical method
2. Solve a linear system of equations and non-linear algebraic or transcendental equation using an appropriate numerical method
3. Calculate a definite integral and evaluate a derivative at a value using an appropriate numerical method
4. Solve an Ordinary differential equation using an appropriate numerical method
5. Solve partial differential equations using an appropriate numerical method

UNIT - I

Introduction, Approximation and concept of Error and Error Analysis: Taylor series expansion, Truncation error. Round-off error vs. Chopping-off error. Propagation of Error.
Linear Systems and Equations Matrix representation, Calculation of Eigen Values and Eigen vectors, Solution by Cramer's rule; Iterative Method— Jacobi iteration; Gauss-Seidel Method,
Chemical Engineering Examples: Material and energy balance problems involving at least 3 simultaneous equations

UNIT - II

Non-linear Algebraic Equations (single and multi variable) Bisection, Newton-Raphson and Secant methods, Multivariate Newton's method

Chemical Engineering Examples: Equation of state (van der Waals, Beattie-Bridgeman, etc.), Friction factor equation etc.

UNIT - III

Interpolation and Approximation: Newton's polynomials and Lagrange polynomials, spline

Interpolation, linear regression, polynomial regression, least square regression.

Chemical Engineering Examples: Free settling velocity of particles, Arrhenius Equation, Specific heat w.r.to temperature etc.

Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation and integration- Rayleigh's equation, Rate equation

UNIT - IV

Ordinary Differential Equations: Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Explicit Adams-Bashforth technique, Implicit Adams-Moulton technique, Predictor-Corrector technique.

Initial and boundary value problems: Orthogonal Collocation, shooting techniques

Chemical Engineering Examples: Rate equation, Steady-state material or energy balance equations etc.

UNIT - V

Solution of partial differential equations: Introduction to Partial Differential Equations, Classification of partial differential equations (PDE's), solution of PDEs by Finite difference techniques, implicit and explicit methods, Cranks Nicolson Method.

Chemical Engineering Examples: unsteady-state one dimensional heat conduction/diffusion equations

Text Books:

1. Numerical Methods for Engineers, Gupta S.K.; 3rd Ed; New Age International, 1995.
2. Numerical Methods for Engineers, Chapra S.C. and Canale R.P.; 5th Ed; McGraw Hill, 2006.
3. Numerical Methods, M. K. Jain, S. R. K. Iyengar, and R. K. Jain, 6th New Age International Publishers, New Delhi, 2012.

Suggested Readings:

1. Introductory Methods of Numerical Analysis, S. S. Sastry, 4th Ed, PHI Learning Pvt. Ltd., 2005
2. Introduction to Numerical Methods in Chemical Engineering, Pradeep Ahuja, PHI Learning Pvt. Ltd., 2010

18CH C 04

MATERIAL AND ENERGY BALANCE COMPUTATIONS

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: This course will help the students to understand the

1. Basis for all further chemical engineering courses that are part of the curriculum.
2. Basic calculations of process engineering.
3. Material balance calculations for with and without chemical reactions.
4. Analysis methods for identifying vapors and liquids
5. Energy balance calculations and its importance.

Course outcomes: At the completion of this course, students will be able to

1. Develop mastery over process calculations relevant to chemical engineering processes
2. Handle elementary flow-sheeting, material and energy balance calculations without and with chemical reactions,
3. Understand different concepts like recycle, bypass and purge.
4. Familiarize with equations of state and properties of gases and liquids, including phase transition
5. Write the energy balance equations for different unit operations

UNIT I

Basic concepts- Introductory concepts of units, physical quantities in chemical engineering, dimensionless groups, "basis" of calculations. Mass and volume relations.

UNIT II

Material Balance: Introduction, Solubility, dissolution and crystallization (single solute systems) – Solving material balance problems without chemical reaction. Unit operations like absorption, distillation, evaporation, crystallization, leaching, and extraction, drying and mixing units under steady state conditions.

UNIT – III

Material Balance with Chemical Reaction: Material Balance with chemical reaction, Concept of stoichiometry and mole balances, examples, including combustion-Proximate and ultimate analysis of coal and analysis of flue gas. Material balances for by-pass, recycle and purge Operations.

UNIT – IV

Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot, Raoult's law. Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use.

UNIT – V

Energy balance: Heat capacity, sensible and latent heat – Heat balances in operations involving phase change – Heat balance over heat exchangers, dryers and simple evaporation systems / Heat balances calculation in processes without chemical reaction- Heat of reaction, Heat of formation, Heat of combustion- Heat balance in reactions, Adiabatic reaction, temperature of products-Heating values of fuels.

Text Books

1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., Pearson India Education Services, 2015.
2. Bhatt, B. I., Vora, S. M., "Stoichiometry", Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2004.

Suggested Readings:

1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons, 2000
2. Hougen, O. A., Watson, K. M., Ragatz, R. A., " Chemical Process Principles, Part-I Material & Energy Balances", Second Edition, CBS Publishers & Distributors, 2004
3. Venkataramani, V., Anantharaman, N., Begum, K. M. Meera Sheriffa, "Process Calculations" , Second Edition, Prentice Hall of India, 2015.
4. Sikdar, D. C., "Chemical Process Calculations", Prentice Hall of India, 2013.

18EG M 01

INDIAN CONSTITUTION

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks

Course Objectives: This course will help the students to understand the

1. The history of Indian Constitution and how it reflects the social, political and economic perspectives of the Indian society.
2. Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Have knowledge of the various Organs of Governance and Local Administration.

Course outcomes: At the completion of this course, students will be able to

1. Understand the making of the Indian Constitution and its features.
2. Have an insight into various Organs of Governance - composition and functions.
3. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
4. Be aware of the Emergency Provisions in India.
5. Understand the Right To equality, the Right To freedom and the Right To Liberty.

Unit-I

Constitution of India - Introduction and salient features . Constitutional history. Directive Principles of State Policy - Its importance and implementation.

Unit II

Union Government and its Administration - Structure of the Indian Union: Federalism, distribution of legislative and financial powers between the Union and the States.

Parliamentary form of government in India. President: role, power and position.

Unit III

Emergency Provisions in India - National emergency, President rule, Financial emergency

Unit IV

Local Self Government - District's Administration Head: Role and Importance. Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.

Panchayati Raj: Introduction, Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments). Village level: Role of Elected and officials.

Unit V

Scheme Of The Fundamental Rights & Duties: Fundamental Duties - the legal status.

Scheme Of The Fundamental Rights - To Equality, to certain Freedom Under Article 19, to Life And Personal Liberty Under Article 21.

Suggested Readings:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, Framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Online Resources:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

18EE M 01

INDIAN TRADITIONAL KNOWELDGE

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks

Course Objectives:

1. To get a knowledge in Indian Culture
2. To Know Indian Languages and Literature and the fine arts in India
3. To explore the Science and Scientists of Medieval and Modern India

Course Outcomes: After completion of this course, students will be able to:

1. Understand philosophy of Indian culture
2. Distinguish the Indian languages and literature
3. Learn the philosophy of ancient, medieval and modern India
4. Acquire the information about the fine arts in India
5. Know the contribution of scientists of different eras.

UNIT-I

Introduction to Culture: Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India

UNIT-II

Indian Languages, Culture and Literature:

Indian Languages and Literature-I: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature, literature of south India.

Indian Languages and Literature-II: Northern Indian languages & literature

UNIT-III

Religion and Philosophy: Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only)

UNIT-IV

Fine arts in India (Art, Technology& Engineering): Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in India, development of science in ancient, medieval and modern India

UNIT-V

Education system in India: Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India

Text Books:

1. Kapil Kapoor, Text and Interpretation: The India Tradition, ISBN: 81246033375, 2005
2. Science in Samskrit, Samskrita Bharti Publisher, ISBN-13: 978-8187276333, 2007
3. S. Narain, Examinations in ancient India, Arya Book Depot, 1993
4. Satya Prakash, Founders of Sciences in Ancient India, Vijay Kumar Publisher, 1989
5. M. Hiriyanna, Essentials of Indian Philosophy, Motilal Banarsidass Publishers, ISBN-13: 978-8120810990, 2014

Suggested Readings:

1. Kapil Kapoor, Language, Linguistics and Literature: The Indian Perspective, ISBN-10: 8171880649, 1994.
2. Karan Singh, A Treasury of Indian Wisdom: An Anthology of Spiritual Learn, ISBN: 978-0143426158, 2016.

18CH C 05

NUMERICAL METHODS IN CHEMICAL ENGINEERING LAB

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

List of Experiments

1. Introduction to use of computers for numerical calculations (1 practical turn)
2. Solution of linear algebraic equations using Gauss elimination, Gauss-Siedel etc. (2 practical turns)
3. Solution of a non-linear equations using bracketing and Newton-Raphson method (2 practical turns)
4. Interpolation and Approximation(2 practical turns)
5. Numerical integration(2 practical turns)
6. Euler method (1 practical turn)
7. Runge-Kutta methods for ODEs (2 practical turns)
8. Solution of system of ODEs using simple methods (1 practical turn)
9. Solution of simple PDEs (2 practical turns)

Text Books:

1. Numerical Methods for Engineers, Gupta S.K.; New Age International, 1995
2. Numerical Methods for Engineers, Chapra S.C. and Canale R.P.; 5th Ed; McGraw Hill 2006

Suggested Readings:

1. Introductory Methods of Numerical Analysis, S. S. Sastry, 4th Ed, PHI Learning Pvt. Ltd., 2005
2. Introduction to Numerical Methods in Chemical Engineering, Pradeep Ahuja, PHI Learning Pvt. Ltd., 2010

18CH C 06

TECHNOLOGY OF SURFACE COATINGS AND OILS LAB

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

List of Experiments

1. Preparation of panels for painting (power coating or liquid paints)
2. Powder particles size analyser
3. Determination of apparent viscosity of paints (only liquid paints)
4. Determination of resistance to scratching under a specified load
5. of a dried film of paint
6. Measurement of paint film thickness using dry film thickness gauge (finish paint)
7. Determination of flexibility and adhesion of the paints (as per 101 BS 3960 m and size ¼ inch)
8. Determination of impact resistance of the painted panel
9. Measurement of hardness of magnesium phosphate coating or zinc phosphate coating
10. Measurement of gloss of painted film at 45 degree angle
11. Determination of drying consistency of different paints
12. Determination of coverage or spreading capacity of different paints
13. Salt Spray Test (only for Powders)
14. Determination of Acid value of given samples
15. Determination of percentage of free fatty acid present in the given
16. sample and its acid value
17. Determination of Iodine value of given sample
18. Determination of saponification value of given oil samples

Text Books:

1. Industrial Hand Books
   a). Berger Protection Protective Coatings – Product Data Manual
   b). Goodlass Nerolac Paints Product Data Manual
2. ICI Paints Quality Manual Book
3. A text book of oil and fat analysis By Cocks & Reid
4. Modern Technology in Oils and Fats Industry, Vol-II, OTAI (NZ)

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Model Curriculum (with effect from 2019-20)
B.TECH (Chemical Engineering)

SEMESTER – IV

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	18CS C05	Basics of Data Structures	2	-	-	3	20	50	2
2	18CH C07	Chemical Engineering Thermodynamics-II	3	1	-	3	30	70	4
3	18CH C08	Fluid mechanics	3	1	-	3	30	70	4
4	18CH C09	Material Science	3	-	-	3	30	70	3
5	18ME C09	Principles of management	3	-	-	2	30	70	3
6	18CE M01	Environment science	2	-	-	2	-	50	Non credit
PRACTICALS									
7	18EG C03	Soft skills lab	-	-	2	2	15	35	1
8	18CS C06	Basics of Data structures	-	-	2	2	15	35	1
Total			**16**	**02**	**04**	-	**170**	**450**	**18**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE - Semester End Examination

18CS C 05

BASICS OF DATA STRUCTURES

Instruction	2 Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	20 Marks
Credits	2

Course Objectives: This course will help the students to understand the

1. Basic linear and non-linear data structures.
1. Analyzing the performance of operations on data structures.
2. Different sorting and searching techniques and their complexities.

Course outcomes: At the completion of this course, students will be able to

1. Understand the basic concepts of data structures.
2. Understand the notations used to analyze the performance of algorithms.
3. Choose and apply an appropriate data structure for a specified application.
4. Understand the concepts of recursion and its applications in problem solving.
5. Demonstrate a thorough understanding of searching and sorting algorithms.

UNIT - I

Introduction: Data Types, Data structures, Types of Data Structures, Operations, ADTs, Algorithms, Comparison of Algorithms, Complexity, Time- space tradeoff.
Recursion: Introduction, format of recursive functions, recursion Vs. Iteration, examples.

UNIT - II

Linked Lists: Introduction, Linked lists and types, Representation of linked list, operations on linked list, Comparison of Linked Lists with Arrays and Dynamic Arrays.

UNIT - III

Stacks and Queues: Introduction to stacks, applications of stacks, implementation and comparison of stack implementations. Introduction to queues, applications of queues and implementations, Priority Queues and applications.

UNIT - IV

Trees: Definitions and Concepts, Operations on Binary Trees, Representation of binary tree, Conversion of General Trees to Binary Trees, Representations of Trees, Tree Traversals, Binary search Tree.

UNIT - V

Graphs:Introduction, Applications of graphs, Graph representations, graph traversals, Minimal Spanning Trees.
Searching and Sorting: Linear searching, binary Searching, sorting algorithms- bubble sort, selection sort, quick sort, heap sort.

Text Books:

1. Narasimhaarumanchi, Data Structures and Algorithms Made Easy, Career Monk Publications, 2017
2. S. Sahni and Susan Anderson-Freed, Fundamentals of Data structures in C,E.Horowitz, Universities Press, 2nd Edition.
3. ReemaThareja, Data Structures using C, Oxford University Press, 2014.

Suggested Readings:

1. D.S.Kushwaha and A.K.Misra, Data structures A Programming Approach with C, PHI, 2011.
2. Seymour Lipschutz, Data Structures with C, Schaums Outlines Series, 1st Ed, 2001.

18CH C 07

CHEMICAL ENGINEERING THERMODYNAMICS-II

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: This course will help the students to understand the

1. Concepts of fugacity, activity coefficient, vapor-liquid equilibrium and reaction equilibrium
2. Concepts of partial molar properties and chemical potential
3. Phase Rule and Various models used to determine the activity coefficients.
4. Generate Vapor- Liquid equilibrium (VLE) in form of T-X-Y or P-X-Y for binary mixtures
5. Concepts of chemical reaction equilibrium

Course outcomes: At the completion of this course, students will be able to

1. Calculate partial molar, residual and excess properties
2. Calculate Fugacity and Fugacity Coefficients for miscible binary Mixtures and also pure species
3. Determine the activity coefficients using various models
4. Generate equilibrium data for VLE
5. Determine equilibrium constant and composition of product mixture at given temperature and pressure

UNIT - I

Criterion of phase equilibrium; Ideal solutions and use of Raoult's Law to generate P-X-Y and t-x-y diagrams for ideal solutions; flash calculations for ideal solutions; non ideal behavior, partial properties; Gibb's – Duhem equation; fugacity and fugacity coefficient for pure components and for species in solution; calculations of fugacity coefficient using generalized correlation; the excess Gibbs energy; Lewis – Randall rule – activity coefficients from vapor-liquid equilibrium (VLE) data

UNIT - II

The nature of Phase equilibrium: the phase rule, Duhem's theorem; description of phase diagrams; low pressure VLE from correlation of data – equations of Margules, van Laar, Wilson, UNIQUAC, UNIFAC; dew-point and bubble – point calculations; flash vaporization calculations; ideal solute behavior based on Henry's law.

UNIT – III

Solution thermodynamics: fundamental residual – property relation and fundamental excess – property relation; evaluation of partial properties and property changes of mixing;

Phase Equilibria: equilibrium and stability; stability requirement for binary vapor-liquid equilibrium; Liquid-Liquid Equilibria; Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid-Gas Equilibria

UNIT - IV

Applications of equations of state; thermodynamic property calculations for fluid mixtures using the generalized correlation's based on the viral equation of state; properties of fluid mixtures using Redlich-Kwong equation of state and Pitzer's correlation's; VLE and flash calculations using the Redilich –Kwong equation of state

UNIT - V

Chemical reaction equilibrium; reaction co-ordinate; equilibrium criteria for chemical reactions; equilibrium constant and the effect of temperature; temperature and pressure effects on conversion; calculation of equilibrium conversion for single reactions in homogenous and heterogeneous systems; Duhem's theorem for reacting systems; simple examples of multi-reaction equilibrium.

Text Books:

1. Introduction to Chemical Engineering Thermodynamics (in SI units) by J M Smith and H C Van Ness and M M Abbott, 7th Edition, Mc-Graw Hill, 2005

Suggested Readings:

1. S.Sandler, " Chemical, Biochemical and Engineering Thermodynamics" , 4th edition, Wiley, India, 2006.
2. A Textbook of Chemical Engineering Thermodynamics by K.V. Narayanan, PHI Pvt. Ltd., 2001
3. Chemical Engineering Thermodynamics by Y V C Rao, Universities Press, 1997

18CH C 08

FLUID MECHANICS

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: This course will help the students to understand the

1. Fluid flow phenomena for incompressible and compressible fluids.
2. Conservation of momentum principles to fluid flow.
3. Flow in Pipes, Channels and flow past immersed bodies.
4. Concepts of Compressible Fluids and Non Newtonian fluids
5. Fluidization phenomena and methods for transporting the fluids

Course outcomes: At the completion of this course, students will be able to

1. Differentiate different types of fluids.
2. Identify equipments to be used to measure fluid flow based on their properties.
3. Design the piping for flow of fluids under different conditions useful for industry.
4. Calculate the energy losses during the transport of fluids through pipes.
5. Deicide the types of pumps for different fluids under different conditions such as toxic, acidic, slurry type.

UNIT - I

Fluid Flow Phenomena and Fluid Statics: Definition of fluid, shear rate and shear stress, Newtonian and Non-Newtonian fluids, Time dependent flow, viscosity and momentum flux, compressible, incompressible, real and ideal fluids, viscosities of gases and liquids, Laminar and Turbulent flows, Reynolds experiment, Boundary layers, Hydrostatic equilibrium, U-tube manometer, inclined manometer and two fluid manometer and inverted manometer.

UNIT - II

Basic Equations of Fluid Flow: path lines, stream lines and stream tube, mass balance–equation of continuity, one dimensional flow, mass velocity, differential momentum balance- equations of motion, coquette flow, macroscopic momentum balances, momentum of stream and momentum correction factor, layer flow with free surface. Mechanical energy equation-Bernoulli equation- corrections for effects of solid boundaries, kinetic energy correction factor, corrections for fluid friction, pump work in Bernoulli equation.

UNIT - III

Incompressible Flow in Pipes and Channels and Frictional Losses: Shear stresses and skin friction, fanning friction factor, flow in noncircular channels, laminar flow of Newtonian and Non-Newtonian fluids, velocity distribution, Hagen-Poiseuille equation, Turbulent flow, universal velocity distribution, Roughness, Moody's friction factor chart. Pipes and valves, fittings. Friction losses due to sudden expansion and contraction, Effects of fittings and valves, form frictional losses in the Bernoulli Equation. Dimensional analysis and Buckingham ð - theorem and Rayleigh theorem its applications and limitations.

UNIT – IV

Compressible Fluids and Non Newtonian fluids (with Differential Pressure estimation) Flow past immersed bodies and Fluidization: Motion of particles through fluids – Free settling and hindered settling, Potential flow, vortisity. Differential analysis: mass and momentum balances, Navier-Stokes equation, Unidirectional flow, Viscous flow, Stokes law, Skin drag and pressure drag and drag coefficient, Flow through packed beds of solids – Kozeny- Carman equation, Burke-Plummer equation and Ergun equation. Boundary layer theory, Blasius solution, Boundary layer separation, Drag and lift force on immersed body.

UNIT – V

Transportation and Metering of Fluids: Centrifugal and Positive Displacement Pumps, Characteristics of pumps, selection and design of pumps, suction lift and cavitation, NPSH, Flow meters- Venturi meter, orifice meters, Pitot tube, Rota meters and Notches and Weirs, Compressors and blowers.

Text Books

1. W. L. McCabe, J. C. Smith and P.Harriott , Unit Operations of Chemical Engineering, 7th Ed., Tata-McGraw Hill Chemical Engineering Series, New Delhi, 2005.
2. C.J.Geankopolis, "Transport processes and unit operations", 3rd Ed., Prentice Hall Publishers, USA, 1993.

Suggested Readings:

1. James O. Wilkes, "Fluid Mechanics for Chemical Engineers with Microfluids and CFD", 2nd Ed., University of Michigan, Prentice Hall Intl., 2006.
2. Kurmi, R.S., "Hydraulics, Fluid Mechanics and Hydraulic Machines", 20th Ed., S. Chand and Company Pvt.Ltd., New Delhi, 2014.

18CH C 09

MATERIAL SCIENCE

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the

1. Basic introduction to different classes of materials relevant to engineering in general and chemical engineering in particular.
2. Significance of different properties for selecting material under different combinations of process conditions.
3. Concept of Semi crystalline and Bio materials.
4. Concept of Nano composite materials
5. Experimental techniques for material characterization.

Course outcomes: At the completion of this course, students will be able to

1. Identify the different classes of materials relevant to engineering
2. Apply the basic fundamentals of engineering for material selection based on their properties
3. Select semi-crystalline materials and bio materials.
4. Select materials for Nano composites.
5. Characterize material using different experimental techniques.

UNIT – I Introduction to Engineering Materials:

Classification – metals, non-metals, alloys; Ferrous metals and alloys - types of steels like mild, carbon and stainless steel, common grades of steel – 304 and 316; Non-Ferrous metals and alloys of Aluminium, Copper and Nickel; Criteria for material selection.

UNIT – II General Properties of Engineering Materials:

Mechanical Properties: Stress-strain diagram, Elastic, Plastic, Anelastic and Viscoelastic behavior. Creep, Fatigue and Fracture strengthening mechanisms. Thermal Properties: Conductivity, Expansion, Protection, Diffusivity, Stresses and Shock resistance. Optical Behavior: Light & electro-magnetic spectrum, Luminescence, stimulated emission of Radiation, Lasers, Optical fibres.

UNIT-III

Semi-crystalline materials: Classification, structure and configuration of ceramics, polymers,
copolymers, liquid crystals and amphiphiles

Non-crystalline/amorphous materials: Silicates, glass transition temperature, viscoelasticity.

Biomaterials: Interaction of materials with bioenvironment, concept of biocompatibility. Need for biomaterials, significant types – inert, surface active and resorbable materials. Their advantages, properties, uses.

UNIT-IV

Polymer nano-composite materials: Nanocomposites, role of reinforcement-matrix interface strength on composite behaviour. Corrosion, Degradation and Recycling

UNIT-V

Introduction to experimental techniques: XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties

Text Books

1. William D. Callister, David G, Rethwisch Materials Science and Engineering: An Introduction, Wiley Publisher, 2002.

2. V. Raghavan Materials Science and Engineering: A First Course, 5th Ed., Prentice Hall India, 2004.

Suggested Readings:

1. S. Upadhyaya and A. Upadhyaya, Material Science and Engineering, Anshan Publications, 2007.
2. B. S. Mitchell An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, John Wiley & Sons, 2004.

18ME C 09

PRINCIPLES OF MANAGEMENT

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: To make the students to

1. Understand basic fundamentals and insights of management
2. Understand the nature and purpose of planning
3. Gain the knowledge about the frame work of organizing
4. Understand the essence and significance of directing
5. Recognize the importance of controlling and its outcomes

Course Outcomes: At the end of the course, student will be able to understand

1. Identify and evaluate the principles of management
2. Demonstrate the ability to have an effective and realistic planning
3. Identify the nature and the type of organization
4. Apply the tools and techniques of directing
5. Explain and evaluate the necessity for controlling and further refinement of an organization.

UNIT - I

Management: Definition of management**,** science or art, manager vs entrepreneur; managerial roles and skills;. Evolution of management, Basic management theories by FW Taylor, Henry Fayol, Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management

UNIT - II

Planning: Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Planning plant location and layout, Decision making steps & processes.

UNIT - III

Organizing: Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management

UNIT - IV

Directing: Individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

UNIT - V

Controlling: system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Text Books:

1. S.P. Robins and M. Couiter, “Management”, 10/e., Prentice Hall India, 2009.
2. JAF Stoner, RE Freeman and DR Gilbert, “Management”, 6/e., Pearson Education, 2004.

Suggested Readings:

1. P.C. Tripathy & P.N. Reddy, “Principles of Management”, Tata McGraw Hill, 1999
2. Harold Koontz and Cyril O’Donnell “Principles of Management’’, Tata McGraw Hill, 2017

18CE M 01

ENVIRONMENTAL SCIENCE

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks

Course Objectives: To enable the student:

1. Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
2. Become aware about the importance of eco system and biodiversity for maintaining ecological balance
3. To identify the importance of interlinking of food chain
4. Learn about various attributes of pollution management and waste management practices.
5. To make the students contribute for capacity building of nation for arresting and/or managing environmental disasters.

Course Outcomes: At the end of the course, the student should have learnt

1. To define environment, identify the natural resources and ecosystems and contribute for the conservation of bio-diversity.
2. To suggest suitable remedial measure for the problems of environmental pollution and contribute for the framing of legislation for protection of environment.
3. To relate the social issues and the environment and contribute for the sustainable development.
4. To follow the environmental ethics.
5. To contribute for the mitigation and management of environmental disasters.

UNIT – I:

Environmental Studies: Definition, Scope and importance, need for public awareness.

Natural resources: Use and over utilization of Natural Resources - Water resources, Food resources, Forest resources, Mineral resources, Energy resources, Land resources.

UNIT – II:

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, role of producers, consumers and decomposers, energy flow in an ecosystem, food chains, food webs, ecological pyramids, Nutrient cycling, Bio-geo chemical cycles, Terrestrial and Aquatic ecosystems.

UNIT – III:

Biodiversity: Genetic, species and ecosystem biodiversity, Bio-geographical classification of India, India as a Mega diversity nation. Values of biodiversity, hot-spots of biodiversity, threats to biodiversity, endangered and endemic species of India, methods of conservation of biodiversity.

UNIT – IV:

Environmental Pollution: Cause, effects and control measures of air pollution, water pollution, marine pollution, soil pollution, noise pollution and Solid waste management, nuclear hazards

Environmental Legislations: Environment protection Act, Air, Water, Forest & Wild life Acts, issues involved in enforcement of environmental legislation, responsibilities of state and central pollution control boards

UNIT – V:

Social issues and the environment: Water conservation methods: Rain water harvesting and watershed management, Environmental ethics, Sustainable development and Climate change: Global warming, Ozone layer depletion, forest fires, and Contemporary issues.

Text Books:

1. Y. Anjaneyulu, “Introduction to Environmental Science”, B S Publications, 2004.
2. Suresh K. Dhameja, “Environmental Studies”, S. K. Kataria& Sons, 2009.

Suggested Readings:

1. C. S. Rao,” Environmental Pollution Control Engineering”, Wiley, 1991.
2. S. S. Dara, “A Text Book of Environmental Chemistry &Pollution Control”, S. Chand Limited, 2006

18EG C 03

SOFT SKILLS LAB

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

Course Objectives: The course will introduce the students to:

1. Imbibe an impressive personality, etiquette, professional ethics & values, effective time management & goal setting.
2. Understand the elements of professional update & upgrade through industry exposure in a mini-live project. Understand confidence building strategies and thereby to make effective presentations through PPTs.
3. Learn what constitutes proper grooming and etiquette in a professional environment. Acquire the necessary skills to make a smooth transition from campus to corporate.

Course Outcomes: After successful completion of the course the students will be able to

1. Be assertive and set short term and long term goals. Also learn to manage time effectively and deal with stress.
2. Win in professional communication situations and participate in group discussions with confidence. Write abstracts.
3. Write effective resumes. Plan, prepare and face interviews confidently.
4. Adapt to corporate culture by being sensitive - personally and sensible - professionally. Draft an SOP.
5. Apply the soft skills learnt in the mini-live project, by collecting and analyzing data and making oral and written presentations on the same.

Exercise 1
Main Topics: Thinking Skills, Personality Development – Effective Time Management, setting realistic goals, self confidence and assertiveness, stress management, moral values.
Flipped Sessions: Personal Sensitivity & Professional Sensibility (Reading & Discussion)
Writing Input: Writing to Express - Drafting & Delivering a Speech (Free Writing Exercise)

Exercise 2
Main Topics: Advanced Group Discussion with Case studies : Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and coherence.

Flipped Sessions: Importance of Professional Updating & Upgrading (Reading & Discussions)
Writing Input: Writing with Precision - Writing Abstracts

Exercise 3
Main Topics: Interview Skills – concept and process, pre-interview planning, opening strategies, answering strategies, mock interviews. Resume' writing – structure and presentation, planning, defining the career objective, projecting ones strengths and skills.
Flipped Sessions: Mock Interviews (Video Sessions & Practice)
Writing Input: Writing to Reflect - Resume Writing

Exercise 4
Main Topic: Corporate Culture – Grooming and etiquette, communication media, academic ethics and integrity
Flipped Sessions: Corporate Culture, Etiquette & Grooming (Video Sessions & Practice through Role-play)
Writing Input: Writing to Define - Writing an effective SOP.

Exercise 5
Main Topic: Mini Project – General/Technical. Research, developing a questionnaire, data collection, analysis, written report and project seminar. Elements & Structure of effective presentation. Presentation tools – Body language, Eye-contact, Props & PPT.
Flipped Sessions: Effective Presentations (Video & Writing Sessions, Practice through Emulation)
Writing Input: Writing to Record - Writing minutes of meeting.

Suggested Readings:

1. Madhavi Apte , "A Course in English communication", Prentice-Hall of India, 2007
2. Dr. Shalini Verma, "Body Language- Your Success Mantra", S Chand, 2006
3. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010
4. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004

* Flipped Class-room: Students explore the concept first and then trainer explains it, students work on their own.

Web Resources:

1. https://www.goskills.com/Soft-Skills
2. https://www.trainerbubble.com
3. https://www.skillsconverged.com

18CS C 06

BASICS OF DATA STRUCTURES LAB

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

Course Objectives: This course will help the students to understand the

1. Design and construct simple programs by using the concepts of Data structures as abstract data type.
2. To have a broad idea about how efficiently pointers can be used in the implement of data structures.
3. To enhance programming skills while improving their practical knowledge in data structures.
4. To strengthen the practical ability to apply suitable data structure for real time applications.

Course outcomes: At the completion of this course, students will be able to

1. Implement the abstract data type.
2. Implement linear data structures such as stacks, queues using array and linked list.
3. Understand and implement non-linear data structures such as trees, graphs and its traversal techniques.
4. Implement various kinds of searching, sorting techniques.
5. Develop the suitable data structure for real world problem.

LIST OF EXPERIMENTS

1. Implementation of operations on arrays.
2. Implementation of Stack.
3. Implementation of Queue.
4. Implementation of basic operations on Single Linked List.
5. Implementation of Searching techniques.
6. Implementation of Sorting techniques.
7. Case study like Banking System, Students Marks Management, Canteen Management etc.

Text Books

1. Brian W Kernighan, Dennis Ritchie, C Programming Language, PH PTR, 2nd Edition.
2. Richard M Reese, Understanding and Using C Pointers,O'Reily , 2013.

Web Links

https://nptel.ac.in/courses/106102064/