List of Employability Courses Revised/Newly Introduced

Department : *Chemical Engineering*

Programme Name : *B.Tech. and M.Tech.*

Academic Year : 2021-22

List of Revised/New Courses

Sr. No.	Course Code	Name of the Course
01.	CH203TPC02	Fluid Mechanics
02.	CH203TPC01	Material And Energy Balance Calculations
03.	CH204TBS07	Numerical Methods In Chemical Engineering
04.	CH204TPC05	Particle And Fluid Particle Processing
05.	CH204TPC06	Process Instrumentation
06.	CHPATT3	Advanced Fluidization Engineering
07.	CHPBTP1	Computational Fluid Dynamics
08.	CHPBTP2	Fuel Cell Technology
09.	CHPBTP5	Industrial Pollution Control

Minutes of Meetings (MoM) of Board of Studies (BoS)

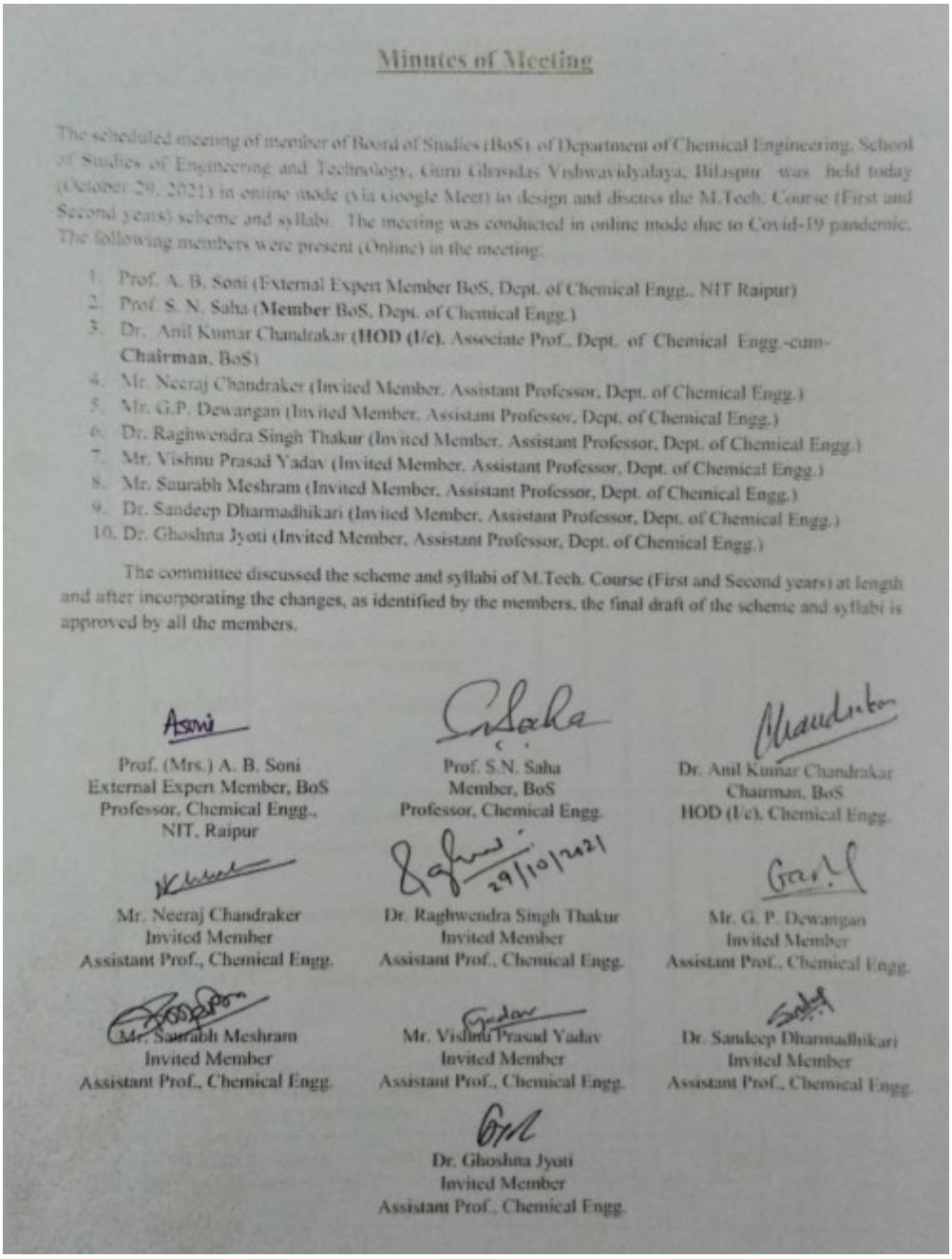
Academic Year : 2021-22

School : *School of Studies of Engineering and Technology*

Department : *Chemical Engineering*

Date and Time : *October 29, 2021 (M.Tech.) & October 1, 2021 (B.Tech.)*

Venue : *Online*



Minutes of Meeting

The scheduled meeting of member of Board of Studies (BoS) of Department of Chemical Engineering, School of Studies of Engineering and Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur was held today (October 29, 2021) in online mode (via Google Meet) to design and discuss the M.Tech. Course (First and Second years) scheme and syllabi. The meeting was conducted in online mode due to Covid-19 pandemic. The following members were present (Online) in the meeting:

1. Prof. A. B. Soni (External Expert Member BoS, Dept. of Chemical Engg., NIT Raipur)
2. Prof. S. N. Saha (**Member** BoS, Dept. of Chemical Engg.)
3. Dr. Anil Kumar Chandrakar (**HOD (I/c)**, Associate Prof., Dept. of Chemical Engg.-cum-**Chairman**, BoS)
4. Mr. Neeraj Chandraker (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
5. Mr. G.P. Dewangan (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
6. Dr. Raghwendra Singh Thakur (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
7. Mr. Vishnu Prasad Yadav (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
8. Mr. Saurabh Meshram (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
9. Dr. Sandeep Dharmadhikari (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
10. Dr. Ghoshna Jyoti (Invited Member, Assistant Professor, Dept. of Chemical Engg.)

The committee discussed the scheme and syllabi of M.Tech. Course (First and Second years) at length and after incorporating the changes, as identified by the members, the final draft of the scheme and syllabi is approved by all the members.

Prof. (Mrs.) A. B. Soni
External Expert Member, BoS
Professor, Chemical Engg.,
NIT, Raipur

Prof. S.N. Saha
Member, BoS
Professor, Chemical Engg.

Dr. Anil Kumar Chandrakar
Chairman, BoS
HOD (I/c), Chemical Engg.

Mr. Neeraj Chandraker
Invited Member
Assistant Prof., Chemical Engg.

29/10/2021
Dr. Raghwendra Singh Thakur
Invited Member
Assistant Prof., Chemical Engg.

Mr. G. P. Dewangan
Invited Member
Assistant Prof., Chemical Engg.

Mr. Saurabh Meshram
Invited Member
Assistant Prof., Chemical Engg.

Mr. Vishnu Prasad Yadav
Invited Member
Assistant Prof., Chemical Engg.

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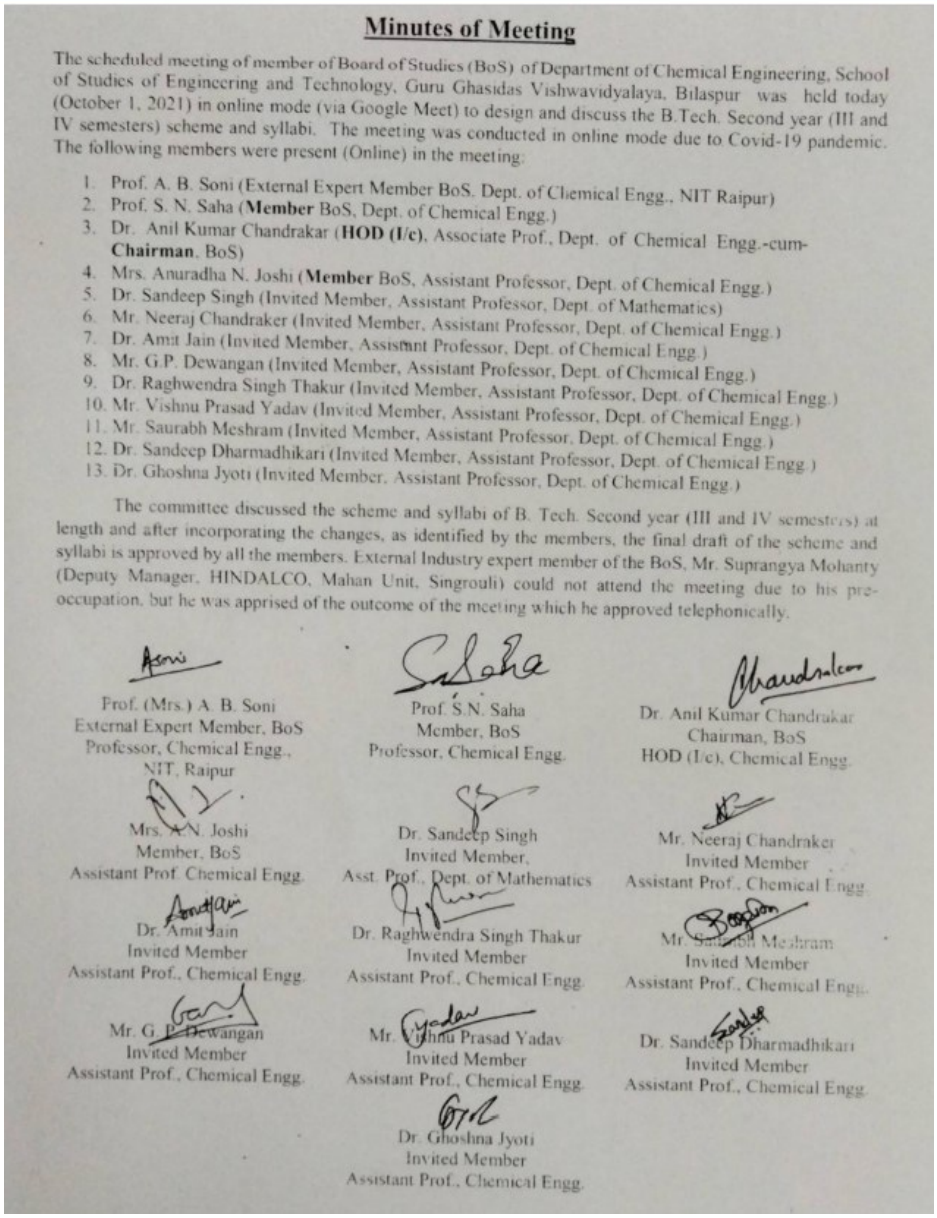

Minutes of Meeting

The scheduled meeting of member of Board of Studies (BoS) of Department of Chemical Engineering, School of Studies of Engineering and Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur was held today (October 1, 2021) in online mode (via Google Meet) to design and discuss the B.Tech. Second year (III and IV semesters) scheme and syllabi. The meeting was conducted in online mode due to Covid-19 pandemic. The following members were present (Online) in the meeting:

1. Prof. A. B. Soni (External Expert Member BoS, Dept. of Chemical Engg., NIT Raipur)
2. Prof. S. N. Saha (**Member** BoS, Dept. of Chemical Engg.)
3. Dr. Anil Kumar Chandrakar (**HOD (I/c)**, Associate Prof., Dept. of Chemical Engg.-cum-**Chairman**, BoS)
4. Mrs. Anuradha N. Joshi (**Member** BoS, Assistant Professor, Dept. of Chemical Engg.)
5. Dr. Sandeep Singh (Invited Member, Assistant Professor, Dept. of Mathematics)
6. Mr. Neeraj Chandraker (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
7. Dr. Amit Jain (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
8. Mr. G.P. Dewangan (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
9. Dr. Raghwendra Singh Thakur (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
10. Mr. Vishnu Prasad Yadav (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
11. Mr. Saurabh Meshram (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
12. Dr. Sandeep Dharmadhikari (Invited Member, Assistant Professor, Dept. of Chemical Engg.)
13. Dr. Ghoshna Jyoti (Invited Member, Assistant Professor, Dept. of Chemical Engg.)

The committee discussed the scheme and syllabi of B. Tech. Second year (III and IV semesters) at length and after incorporating the changes, as identified by the members, the final draft of the scheme and syllabi is approved by all the members. External Industry expert member of the BoS, Mr. Suprangya Mohanty (Deputy Manager, HINDALCO, Mahan Unit, Singrouli) could not attend the meeting due to his pre-occupation, but he was apprised of the outcome of the meeting which he approved telephonically.

Prof. (Mrs.) A. B. Soni
External Expert Member, BoS
Professor, Chemical Engg.,
NIT, Raipur

Prof. S.N. Saha
Member, BoS
Professor, Chemical Engg.

Dr. Anil Kumar Chandrakar
Chairman, BoS
HOD (I/c), Chemical Engg.

Mrs. A.N. Joshi
Member, BoS
Assistant Prof. Chemical Engg.

Dr. Sandeep Singh
Invited Member,
Asst. Prof., Dept. of Mathematics

Mr. Neeraj Chandraker
Invited Member
Assistant Prof., Chemical Engg.

Dr. Amit Jain
Invited Member
Assistant Prof., Chemical Engg.

Dr. Raghwendra Singh Thakur
Invited Member
Assistant Prof., Chemical Engg.

Mr. Saurabh Meshram
Invited Member
Assistant Prof., Chemical Engg.

Mr. G. P. Dewangan
Invited Member
Assistant Prof., Chemical Engg.

Mr. Vishnu Prasad Yadav
Invited Member
Assistant Prof., Chemical Engg.

Dr. Sandeep Dharmadhikari
Invited Member
Assistant Prof., Chemical Engg.

Dr. Ghoshna Jyoti
Invited Member
Assistant Prof., Chemical Engg.

The following courses having focus on employability were revised in the of B. Tech. Second year (III and IV Semesters) and M. Tech.:

- Material and Energy Balance Calculations (CH203TPC01)
- Fluid Mechanics (CH203TPC02)
- Numerical Methods in Chemical Engineering (CH204TBS07)
- Particle and Fluid Particle Processing (CH204TPC05)
- Process Instrumentation (CH204TPC06)
- Advanced Fluidization Engineering (CHPATT3)
- Industrial Process Control (CHPBTP5)

The following courses having focus on employability were newly introduced in the of B. Tech. Second year (III and IV Semesters) and M. Tech.:

Advanced Separation Processes (CHPATT2)

- Computational Fluid Dynamics (CHPBTP1)
- Fuel Cell Technology (CHPBTP2)

विभागाध्यक्ष, रासायनिक अभियांत्रिकी
HoD, Chemical Engineering
प्रौद्योगिकी संस्थान/Institute of Technology
गुरु घासीदास विश्वविद्यालय, बिलासपुर (छ.ग.)
Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.)

Signature & Seal of HoD

Scheme and Syllabus

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

SCHEME FOR EXAMINATION (Effective from Session 2021-22)

B.TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

SECOND YEAR, THIRD SEMESTER (AICTE-NEW)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
	THEORY					Sessional			
			L	T	P	IA	ESE	TOTAL	
01.	CH203TBS05	Biology	3	0	0	30	70	100	3
02.	CH203TBS06	Mathematics-III	3	1	0	30	70	100	4
03.	CH203TPC01	Material and Energy Balance Calculations	3	1	0	30	70	100	4
04.	CH203TPC02	Fluid Mechanics	3	1	0	30	70	100	4
05.	CH203TPC03	Thermodynamics-I	3	0	0	30	70	100	3
	PRACTICAL								
01.	CH203PPC01	Chemical Engineering Lab-I	0	0	3	30	20	50	1.5
02.	CH203PPC02	Fluid Mechanics Lab	0	0	3	30	20	50	1.5
		Total	15	3	6			600	21

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
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SCHEME FOR EXAMINATION (Effective from Session 2021-22)
B.TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING
SECOND YEAR, FOURTH SEMESTER (AICTE-NEW)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
	THEORY					Sessional			
			L	T	P	IA	ESE	TOTAL	
01.	CH204THS02	Business Communication and Presentation Skill	3	0	0	30	70	100	3
02.	CH204TBS07	Numerical Methods in Chemical Engineering	3	1	0	30	70	100	4
03.	CH204TPC04	Thermodynamics-II	3	0	0	30	70	100	3
04.	CH204TPC05	Particle and Fluid Particle Processing	3	1	0	30	70	100	4
05.	CH204TPC06	Process Instrumentation	3	1	0	30	70	100	4
	PRACTICAL								
01.	CH204PBS03	Numerical Methods in Chemical Engineering lab	0	0	2	30	20	50	1
02.	CH204PPC03	Particle and Fluid Particle Processing lab	0	0	3	30	20	50	1.5
03.	CH204PPC04	Process Instrumentation Lab	0	0	3	30	20	50	1.5
		Total	15	3	8			650	22

IA – Internal Assessment ESE - End Semester Examination Total Credits : 22

CH203TPC01 Material and Energy Balance Calculations [L:3, T:1, P:0]

Objectives:

The course will serve as a basis for all further chemical engineering courses that are part of the curriculum.

Unit I : Introductory concepts of units, physical quantities in chemical engineering, Dimensionless groups, "basis" of calculations Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius Clapeyron equation, Cox chart, Duhring's plot, Raoult's law.

Unit II : Humidity and saturation, humid heat, humid volume, dew point, humidity chart and its use.

Unit III : Material Balance: Introduction, solving material balance problems without chemical reaction, material balances with recycle, bypass and purge, material balance with chemical reaction, concept of stoichiometry and mole balances, examples, including combustion.

Unit IV : Energy Balance: open and closed system, heat capacity, calculation of enthalpy changes.

Unit V : Energy balances with chemical reaction, heat of reaction, heat of combustion.

Suggested Text Books:

1. S. N. Saha, "Chemical Process Engineering Calculation", Dhanpat Rai Publication Co. (Pvt.) Ltd., New Delhi
2. B. I. Bhatt & S. M. Vora, "Stoichiometry", Tata McGraw Hill Publishing Co. Ltd.

Suggested References Books:

1. R. M. Felder & R. W. Rousseau, "Elementary Principles of Chemical Processes", John Wiley & Sons.
2. O. A. Hougen, K. M. Watson & R. A. Ragatz, "Chemical Process Principles, Part I Material & Energy Balances", CBS Publishers & Distributors.
3. D. M. Himmelblau & J. B. Riggs, "Basic Principles and Calculations in Chemical Engineering", Pearson India Education Services.
4. V. Venkataramani, N. Anantharaman, K. M. Begum & S. Meera, "Process Calculations", Prentice Hall of India.
5. D. C. Sikdar, "Chemical Process Calculations", Prentice Hall of India.

Outcomes:

Students completing the course will

- Develop mastery over process calculations relevant to Chemical Engineering Processes
- Be able to handle elementary flow-sheeting, material and energy balance calculations
- Be able to solve problems based on without and with chemical reactions, and involving concepts like recycle, bypass and purge.
- Be familiar with equations of state and properties of gases and liquids, including phase transition.

CH203TPC02 **Fluid Mechanics** **[L:3, T:1, P:0]**

Objectives:

The objective of this course is to introduce the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations. The course will impart the knowledge of basic concepts of kinematics of flow, different forces on fluids, flow visualization, flow measurement, flow transportation and types of flow.

Unit I : Fluid Static & Applications: Hydrostatic equilibrium, hydrostatic equilibrium in centrifugal field and its applications in chemical engineering like manometers decanters. Fluid Flow Process: velocity gradient and shear, types of fluids, concept of viscosity, kinematic viscosity, nature of flow- laminar, turbulent, Reynolds number, boundary layer formation and separation.

Unit II : Basic Equations for Fluid Flow: Mass balance & momentum balance equations, Bernoulli's equation without and with corrections for solid boundaries, kinetic energy, friction factor, pump work.

Unit III : Incompressible Fluids : Flow through pipes, flow characteristics- shear stress, friction factor, laminar flow for newtonian fluids, Hagen Poiseuille equation, laminar flow for non-newtonian liquids, turbulent flow through pipes and close channels and its characteristic equations, friction factor and its dependence on roughness, Reynolds number, friction factor for flow through channels of non-circular cross section – concept of equivalent diameter, frictional losses due to sudden change in velocity or direction of flow; expansion, contraction, effect of fittings, flow of liquids in thin layers.

Unit IV : Transportation of Fluids: pipe fitting like bends, elbows, flanges, tee and different types of valves, seals for moving parts, pumps, NPSH, power requirement, types of pumps – centrifugal & positive displacement, trouble shooting in operation – priming & cavitation, characteristic curves – head / capacity / power / efficiency, capacity- head flow and head work relationship, metering of fluids: variable head meters- venturi meter & orifice meter, variable area meter – rotameter, insertion meters – pitot tube.

Unit V : Differential analysis: mass and momentum balances, Navier-Stokes equation, unidirectional flow, viscous flow, Stokes law, skin drag and pressure drag, potential flow, potential function, solution of Laplace equation.

Suggested Text Books :

1. M. White, Fluid Mechanics, Tata-McGraw Hill.
2. V. Gupta & S. K. Gupta, Fundamentals of Fluid Mechanics, New Age International.
3. W. L. McCabe, J. C. Smith & P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition.

4. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India.
5. R. W. Fox, P. J. Pritchard & A. T. McDonald, Introduction to Fluid Mechanics, Wiley-India.
6. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, Wiley.

Suggested References Books :

1. B. R. Munson, D. F. Young, T. H. Okiishi & W. W. Huebsch, Wiley-India.
2. R. L. Panton, Incompressible Flow, Wiley-India.
3. R. B. Bird, W. E. Stewart & E. N. Light foot, Transport Phenomena, Wiley India.

Outcomes :

- Velocity profiles by simplification of equations of motion in simple 1-D flows
- Boundary layer thicknesses, friction factor, pressure drop, power requirements in single phase flow in pipes
- Two phase gas/liquid pressure drop
- Power requirements, NPSH requirements of pumps

Students should be able to :
- Communicate properly, write technical letters and reports.
- Present reports and seminars in an attractive way.

CH204TBS07 Numerical Methods in Chemical Engineering [L:3, T:1, P:0]

Objectives:

The objective of this subject is to introduce students to numerical methods used to solve engineering problems, in particular chemical engineering problems, using numerical methods and computer programming.

Unit I : Introduction of errors and their analysis, types of errors, numerical problems on error analysis, curve fitting: method of least squares, fittings of straight line and parabola and by method of moments.

Unit II : Numerical Solution of Algebraic and Transcendental Equations: Secant method, Regula-falsi Method, Newton Raphson method, solution of a system of simultaneous linear algebraic equations direct method: Gauss elimination method, iterative methods, Gauss Seidel iterative method.

Unit III : The Calculus of Finite Differences: Finite differences, difference formula, operators and relation between operators, inverse operator, interpolation with equal intervals: - Newton's forward and backward interpolation formula, interpolation with unequal intervals: - Lagrange's interpolation.

Unit IV : Numerical Differentiation and Integration: Numerical differentiation Newton's forward and backward difference interpolation formula. Numerical Integration: Trapezoidol rule, simpson's $1/3^{rd}$ and $3/8^{th}$ rule, Boole's rule, Weddle rule.

Unit V: Numerical solution of ordinary differential equation: Taylor series method, Euler's method, Modified Euler method Range's method Runge-Kutta method.

Books Recommended:

1. Jain & Iyngar, Numerical Methods for Scientific and Engineering Computations.
2. G. S. Rao, Numerical Analysis.
3. B. S. Grewal, Numerical Methods in Engineering and Science.
4. H. K. Das, Advance Engineering Methods.
5. V. Rajaraman, Computer Oriented Numerical Methods

Outcomes:

After successful completion of this course students will be able to solve chemical engineering problems involving linear and non-linear equations and solve ordinary differential equations.

- Evaluate the equilibrium constant for chemical reactions.

CH204TPC05 Particle and Fluid Particle Processing [L:3, T:1, P:0]

Objectives :

Objective of this course is to introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle fluid interactions are important. The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed. The course is concluded with an introduction to colloidal systems, soft materials and nanoparticles. Applications of these novel systems are discussed.

Unit I: Solids Properties, Handling, Mixing : Introduction: Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes. Solid particle characterization: Particle size, shape and their distribution, Screen analysis, standard screens; Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area. Mixing and storage of Solids: Types of important mixers like kneaders, dispersers, masticaters, roll mills, muller mixer, pug mixer, blender, screw mixer etc., mixing index.

Unit II: Storage and Transportation, Size Reduction : Types of storage equipments, Bin, Silo, Hoper, etc. Transport of fluid-solid systems: mechanical conveying, pneumatic and hydraulic conveying. Major equipment's- Crushers, grinders, ultrafine grinders, laws of communition, Close circuit and open circuit grinding.

Unit III: Fluid Solid Separation : Sedimentation: Elutraition, Classification and sedimentation, Free Settling, hindered settling, flow of solids through fluid, Stoke's law, Richardson-Zaki equation, design of settling tanks. Centrifugal separation, design of cyclones and hydro cyclones, filter bags, venturi scrubber, electrostatic precipitator.

Unit IV: Mechanical Separation and Filtration : Industrial screen; their capacity and effectiveness. Types of filtration, principle of filtration, plate and frame filter, leaf filter, rotary drum filter, etc.

Unit V: Fluidization : Fluidization: Fluidized bed, minimum fluidization velocity, pressure drop etc. Types of fluidization: Particulate fluidization, Bubbling fluidization, Applications of fluidization. Packed bed: Void fraction, superficial velocity, channelling, Ergun equation and its derivation, Kozeny Carman equation, Darcy's law and permeability, Blaine's apparatus.

Suggested Text Books :

1. W. McCabe, J. Smith, J. & P. Harriott, Unit Operations of Chemical Engineering,

Outcomes:

Students will be able to

- Calculate pressure drop in fixed and fluidized beds.
- Know the significance and usage of different particulate characterization parameters, and equipment to estimate them.
- Describe Size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment.
- Analyse filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage.

CH204TPC06 **Process Instrumentation** [L:3, T:1, P:0]

Objectives:

This course is to introduce students to learn the basics of instrumentation and handling the process variables, course address fundamentals & amp; operation of different measuring devices such as temperature, level, pressure, flow, pH, humidity and compositions. Course introduced to impart basic knowledge of transmitters, transducers, control valves, digital and analog components related to PLC, DCS.

Unit I : Instruments Characteristics: Introduction to process variables, static and dynamic characteristics of instruments, and their general classification, elements of measuring system and their functions.

Unit II: Transmitters & amp; Transducers: Signal transmission, transmitters, electronic, pneumatic, transducers.

Unit III: Measuring Instruments : Principles, construction and operations of instruments for the measurement of various process variables such as temperature, pressure, flow, liquid level, humidity, viscosity and composition.

Unit IV: Controllers & amp; Regulators : Principles and construction of electro- pneumatic controllers, multiplexers, final control elements such as pneumatic control vale, stepper motor.

Unit V: Data Acquisition & amp; Analysis : Introduction to data acquisition system and intelligent instruments, instrumentation of process equipment such as distillation column, heat exchanger etc.

Text Books:

1. S. K. Singh, Industrial Instrumentation and Control, McGraw-Hill.
2. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGrawHill.

References Books:

1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw-Hill Publishing Co. Ltd.
2. T. G. Beckwith, R. D. Marangoni & J. H. Lienhard, Mechanical Measurements, Addison Wesley.
3. R. K. Jain, Mechanical and Industrial Measurements, Khanna Publishers, New Delhi
4. C. D. Johnson, Process Control Instrumentation Technology, Pearson Education, Inc.

Outcomes :

Students will be well-familiar with instrumentation and automation as relevant to modern chemical plant operation.

DEPARTMENT OF CHEMICAL ENGINEERING
SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY, GGV, BILASPUR, C.G.
(INDIA)

SCHEME OF EXAMINATION

M.TECH. CHEMICAL ENGINEERING

M.Tech. I-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	CHPATT1	Advanced Heat Transfer	3	0	0	40	60	100	3
2.	CHPATT2	Advanced Separation Processes	3	0	0	40	60	100	3
3.	CHPATT3	Advanced Fluidization Engineering	3	0	0	40	60	100	3
4.		Elective – I	3	0	0	40	60	100	3
	CHPATP1	Advanced Reaction Engineering							
	CHPATP2	Advanced Wastewater Treatment Technology							
	CHPATP3	Advanced Chemical Process Modeling							
5.		Elective – II	3	0	0	40	60	100	3
	CHPATP4	Advanced Process Control							
	CHPATP5	Process Intensification							
	CHPATP6	Bioprocess Engineering							
6.	CHPALT1	Chemical Engineering Computational Lab	0	0	4	30	20	50	2
7.	CHPATC1	Research Methodology and IPR	2	0	0	-	50	50	2
		Total						600	19

M.Tech. II-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	CHPBTT1	Advanced Transport Phenomena	3	0	0	40	60	100	3
2.	CHPBTT2	Chemical Reactor Design	3	0	0	40	60	100	3
3.		Elective – III	3	0	0	40	60	100	3
	CHPBTP1	Computational Fluid Dynamics							
	CHPBTP2	Fuel Cell Technology							
	CHPBTP3	Process Plant Design & Flow Sheeting							
4.		Elective – IV	3	0	0	40	60	100	3
	CHPBTP4	Design & Development of Catalyst							
	CHPBTP5	Industrial Pollution Control							
	CHPBTP6	Safety Hazards & Risk Analysis							
5		Open Elective	3	0	0	40	60	100	3
	MSPBTO1	1. Business Analytics							
	IPPBTO2	2. Industrial Safety							
	IPPBTO3	3. Operations Research							
	CEPBTO4	4. Cost Management of Engineering Projects							
	MEPBTO5	5. Composite Materials							
	CHPBTO6	6. Waste to Energy							
	ECPBTO7	7. Internet of Things							
	MCPBTO8	8. MOOCs							
6.	CHPBLT1	Advanced Chemical Engineering Lab	0	0	4	30	20	50	2
7.	CHPBPT1	Mini Project	0	0	4	30	20	50	2
8.		Audit Course/Value Added Course	2	0	0	0	0	0	0
	ELPBTX1	English for Research Paper Writing							
	PEPBTX2	Stress Management by Yoga							
	CEPBTX3	Disaster Management							
	LAPBTX4	Constitution of India							
		Total						600	19

Note: Under MOOCs the students have to opt any subject other than Chemical Engineering from NPTEL/UGC SWAYAM

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPATT3	ADVANCED FLUIDIZATION ENGINEERING	3:0:0	3

Course Objective :

- To study the phenomenon of fluidization with industrial processing objective
- To study the various regimes of fluidization and their mapping
- To study the design of equipments based on fluidization technique

Course Content:

Introduction to fluidization and applications: Phenomenon of fluidization, behavior of fluidized bed, contacting modes, advantages and disadvantages of fluidization, fluidization quality, selection of contacting mode, Fluidized Beds for Industrial Applications like coal gasification, synthesis reactions, physical operations, cracking of hydrocarbons. Mapping of fluidization regimes: Characterization of particles, mechanics of flow around single particles, minimum fluidization velocity, pressure drop versus velocity diagram, The Geldart classification of solids, fluidization with carryover of particles, terminal velocity of particles, distributor types, gas entry region of bed, pressure drop requirements, various distributor plates, design of distributor plate. Bubbling fluidized beds: Davidson model for gas flow at bubbles in a fluidized bed, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slug flow, Turbulent and fast fluidization - mechanics, flow regimes and design equations, Emulsion movement, estimation of bed properties, bubble rise velocity, scale up aspects, flow models, two phase model, K-L model. Solids movement and Gas dispersion: Vertical and horizontal movement of solids, Dispersion model, large solids in beds of smaller particles, staging of fluidized beds Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient, Heat and mass transfer in fluidized systems, Mixing in fluidized systems - measurements and models. Entrainment or Elutriation of Fluidized Beds , Reactors : Entrainment and elutriation, Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization, Slugging, Spouted beds, Circulating Fluidized Beds. Mathematical model of a homogeneous fluidized bed, Design of catalytic reactors, pilot plant reactors, information for design, bench scale reactors, design decisions, deactivating catalysts, Design of no catalytic reactors, kinetic models for conversion of solids, models for shrinking particles, conversion of solids of unchanging size

Course Outcomes :

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

- Performing and understanding the behavior fluidization in fluidized bed
- Evaluate the characterization of particles and power consumption in fluidization regimes
- Understanding the applicability of the fluidized beds in chemical industries

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPBTP1	COMPUTATIONAL FLUID DYNAMICS	3:0:0	3

Course Objective :

- To provide an introduction to the scientific principles and practical engineering applications of computational fluid dynamics
- To give exposure to the commercial software ANSYS Fluent

Course Content :

Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations, Review of Navier-Stokes Equation and simplified forms, grid generation, structured and unstructured grids, choice of suitable grid, grid transformation of equations, some modern developments in grid generation for solving engineering problems, CFD essentials, Finite difference method (FDM), finite volume method (FVM) and finite element method (FEM): Discretization of ODE and PDE, , Explicit and Implicit scheme to solve heat and fluid flow problems, Application of 1st order and 2nd order Upwind Scheme, Application of SIMPLE, SIMPLER algorithm to solve fluid flow problems, Simulation of CFD problems using Fluent.

Course Outcome :

After learning the course, the students will be able to:

1. To discretize the momentum, mass and energy transport equations by finite volume technique.
2. To understand the subject of Computational Fluid Dynamics and know how to use it as tool to solve the Heat Transfer and Fluid Mechanics related Industrial Problems.
3. To solve some problems with the help of the ANSYS Fluent software.

Texts Books :

- Anderson J.D., Computational fluid dynamics, McGraw Hill
- Date A. W., Introduction to Computational Fluid Dynamics, Cambridge University Press

Reference Books :

- Versteeg H. K. and Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical
- Muralidhar K., and Sundararajan T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House
- Patankar Suhas, Numerical Methods in Fluid Flow & Heat Transfer, CRC Press

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPBTP2	FUEL CELL TECHNOLOGY	3:0:0	3

Course Objective:

- Demonstrate a thorough understanding of the fuel cell power plant's and its components' performance characteristics
- Describe the performance and design characteristics of various fuel cells, as well as operational issues
- Discuss the design philosophy and challenges that must be overcome in order for this power plant to be economically viable
- Thermodynamics and electrochemistry will be the focus of the design and analysis

Course Content :

Low and high temperature fuel cells are discussed in this overview of hydrogen energy and fuel cells. Polymer electrolyte fuel cells, Alkaline fuel cells, Phosphoric fuel cells, Molten carbonate fuel cells, Solid oxide fuel cells, Microbial fuel cells, Fuel cell systems, and Sample calculations are all examples of fuel cell performance. Thermodynamics of fuel cells: heat, work potentials, reversible voltage prediction, and fuel cell efficiency. Electrocatalysts-design, activation kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents, fuel cell reaction kinetics-electrode kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents, electrocatalysts-design, activation kinetics Charge and mass transport in a fuel cell-flow field, transport in the electrode, and transport in the electrolyte Characterization of fuel cells:- characterization techniques in-situ and ex-situ, I-V curve, frequency response analyses Materials Science and Engineering, Process Safety and Process Design

Course Outcomes :

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

1. Apply know-how of thermodynamics, electrochemistry, heat transfer, and fluid mechanics principles to design and analysis of this emerging technology
2. Have thorough understanding of performance behaviour, operational issues and challenges for all major types of fuel cells
3. Identify, formulate, and solve problems related to fuel cell technology keeping in mind economic viability
4. Use the techniques, skills, and modern engineering tools necessary for design and analysis of innovative fuel cell systems
5. Understand the impact of this technology in a global and societal context

Texts Books :

- Larminie J. and Dicks A., Fuel Cell Systems Explained, , John Wiley & Sons Inc.
- Barbir Frano, PEM Fuel Cells Theory and Practice, Elsevier Academic Press
- Hoogers G., Fuel Cell Technology Handbook, SAE International

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPBTP5	INDUSTRIAL POLLUTION CONTROL	3:0:0	3

Course Objective :

- To understand the importance of industrial pollution and its abatement
- To study the underlying principles of industrial pollution control
- To acquaint the students with case studies
- Student should be able to design complete treatment system

Course Content :

Air pollution Sources and Effects, Air pollution laws and standards; Air pollution sampling and measurement from point, non-point, line and area sources, analysis of air pollutants; Air pollution control methods and equipment, Design details of Particulate emission control equipments like Gravitational settling Chamber, Cyclone Separator, Fabric Filter, Electrostatic Precipitator, Wet scrubber; Case studies of a few industrial pollution control system. Sources, effects and laws of water pollution; BOD, COD; Waste water treatment, Design details of Primary Treatment methods like Pretreatment, Sedimentation, Floatation, Design aspects of Secondary Treatment methods like Activated Sludge Process, Trickling Filter. Design aspects of Advanced waste water treatment including Ion Exchanger, Reverse Osmosis, Electrodialysis, Advanced Biological Systems. Solid Waste Management, design calculation of disposal methods, Incineration, Hazardous Waste Management strategy and treatment methods, landfill closure and underground disposal.

Course Outcome :

After learning the course, the students will be able to:

1. Recognize the causes and effects of environmental pollution
2. Analyze the mechanism of proliferation of pollution
3. Develop methods for pollution abatement and waste minimization
4. Design treatment methods for gas, liquid and solid wastes

Texts Books :

- Schnelle K.B. and Brown C.A., Air Pollution Control Technology Handbook, CRC Press
- Peavy H.S., Rowe D.R. and Tchobanoglous G., Environment Engineering, McGraw-Hill

Reference Books :

- Trivedy R.K. and Goel P.K., An Introduction to Air Pollution, Technoscience Pub.
- Sengar D.S., Environmental Law, PHI
- B. Chawla, Jain A.K., Jain A.K., Waste Water Engineering