MINUTE OF MEETING OF BOARD OF STUDIES (BOS) IN CHEMICAL ENGINEERING HELD ON 23RD APRIL 2016 AT 10:30 AM IN THE CONFERENCE HALL OF CHEMICAL ENGINEERING AT BANASTHALI VIDYAPITH.

PRESENT

1.	Prof. S. P. Chaurasia	External Member
2.	Dr. Somen Jana	Internal Member
3.	Mr. Ashok Kumar Yadav	Internal Member
4.	Mr. Deepak Kumar	Internal Member
5.	Ms. Meenakshi	Internal Member
6.	Mr. Sandeep Kumar Patel	Internal Member
7.	Mr. Saurabh Joshi	Internal Member
8.	Ms. Vibha Verma	Internal Member
9.	Dr. Satish C. Shukla	Convener

Summary of BOS Meeting 2015-16

Before taking up the agenda of the meeting, the convener accorded a warm welcome to the external and the internal members of the BOS, on behalf of the chemical engineering department.

Agenda No. 1: Minutes of BOS held on 10th March 2012

It has been observed that recommendations made in the BOS of 2012 are already being followed. Hence the minutes may be taken as deemed to be confirmed.

Agenda No. 2: Panel of Examiners

The BOS updated the existing panel of examiners in each paper of third, fourth, fifth, sixth, seventh and eighth semester examinations of B. Tech. (given in **Annexure-I (A)** from **Page No. 4-23**) as well as first and second semester examinations of M. Tech. (given in **Annexure-I (B)** from **Page No. 24-33**) offered by the Chemical Engineering department in accordance with the Byelaws **15.3.02** of the vidyapith. The updated list has been sent to the secrecy section.

Agenda No. 3: Courses of study, Curricula and Scheme of Examination

The board reviewed the courses of study, curricula and scheme of examinations of the following Examinations:

Bachelor of Technology (Chemical Engineering) Examination:

I. First Semester Examination, December-2016
II. Second Semester Examination, April/May-2017
III. Third Semester Examination, December-2017

IV. Fourth Semester Examination, April/May-2018
V. Fifth Semester Examination, December-2018
VI. Sixth Semester Examination, April/May-2019
VII. Seventh Semester Examination, December-2019
VIII. Eighth Semester Examination, April/May-2020

The board approved the existing courses/schemes of examinations/curricula for the examinations listed above with a proposal to split two lengthy courses into four as in other reputed universities, as mentioned below:

1. CE 4.5 Fluid & Fluid-Particle Operations into two separate courses i.e. (i) Fluid Mechanics, and (ii) Mechanical Operations

2. CE 5.7 Mass Transfer in two separate courses i.e. (i) Mass Transfer-I, and (ii) Mass Transfer-II

. The BOS members brought to notice that there are too many experiments in the lab courses Chemical Engineering Lab.-I & II in the existing curriculum. Members were of the opinion that a new laboratory course should be introduced in place of Analytical Techniques Lab and all laboratory courses should be renamed and restructured according to courses taught. Proposed examination scheme is given in **Annexure-II (A**) from **Page No. 34-37** and syllabus is given in **Annexure-III (A)** from **Page No. 39-46**.

Master of Technology (Chemical Engineering) Examination:

I. First Semester Examination, December-2016
II. Second Semester Examination, April/May-2017
III. Third Semester Examination, December-2017
IV. Fourth Semester Examination, April/May-2018

The board approved the existing courses/schemes of examinations/curricula for the examinations listed above with changes in the syllabi/evaluation schemes for a few papers. Proposed examination scheme is given in **Annexure-II (B)** on **Page No. 38** and syllabus is given in **Annexure-III (B)** from **Page No. 47-50**.

Agenda No. 4: To recommend text books for under-graduate programme

The board has reviewed text books for all courses offered by the Chemical Engineering department. No new text book has been proposed for the existing courses.

Agenda No. 5: Ways & means to strengthen continuous assessment policy

BOS reviewed and recommended no changes in existing continuous assessment policy (two assignments & two periodicals) for existing theory courses of the vidyapith. However, BOS suggested

that a similar assessment policy (by way of submitting monthly progress report to the respective supervisor in the department at Banasthali Vidyapith) should also be followed for B. Tech. Project/Industrial Visit (CE 7.1) as well as for M. Tech. III & IV Semester Dissertation (Part-I and Part-II) work.

Agenda No. 6: To evaluate examiners' reports of the examinations of 2014-15

The BOS received the reports of examiners of third, fourth, fifth and sixth semester B.Tech. (Chemical Engineering) examinations 2014-2015 and all reports were found to be satisfactory.

Agenda No. 7: To evaluate question papers of the examinations of 2014-15

The board critically analyzed the question papers of third, fourth, fifth, sixth, seventh and eighth semester of B.Tech. Chemical Engineering as well as first and second semester examinations of M. Tech. Chemical Engineering of 2014-15 and observed that all the question papers were balanced on the basis of desired parameters (Analytical, Descriptive, Thought provoking and Application based) and considering the nature of individual courses. The detailed analysis of individual question paper is given in **Annexure-IV (A)** from **Page No. 51-54** and **Annexure-IV (B)** from **Page No. 55-56**.

Agenda No. 8: Co-opt external members for 3 years commencing from 1st January 2017

Three external members of the BOS have been co-opted for a period of three years commencing from 1st January 2017 under bye-law 9.2.03 (given in **Annexure-V** on **Page No. 57**).

BOS was concluded with a vote of thanks to all the members.

EXAMINATION SCHEME FOR B. TECH. 2ND YEAR CHEMICAL ENGINEERING

B. Tech. Third Semester									Remark
Existing scheme					Proposed scheme				
Course No.	**Course Title**	**T**	**P**		**Course No.**	**Course Title**	**T**	**P**	NO CHANGE IN EXAMINATION SCHEME
CE 3.1	Probability and Statistics / Mathematics-III	4	-		CE 3.1	Probability and Statistics / Mathematics-III	4	-	
CE 3.2	Mechanics / Electrical Engineering	4	-		CE 3.2	Mechanics / Electrical Engineering	4	-	
CE 3.3	Data Structures	4	4		CE 3.3	Data Structures	4	4	
CE 3.4	Structure and Properties of Materials / Technical Report Writing	4	-		CE 3.4	Structure and Properties of Materials / Technical Report Writing	4	-	
CE 3.5	Chemical Process Calculations	4	-		CE 3.5	Chemical Process Calculations	4	-	
CE 3.6	Heat Transfer	4	-		CE 3.6	Heat Transfer	4	-	
F 3.1	Selected Writings for Self Study-I	2	-		F 3.1	Selected Writings for Self Study-I	2	-	
	Total	**26**	**04**			**Total**	**26**	**04**	

B. Tech. Fourth Semester									Remark
Existing scheme					Proposed scheme				
Course No.	**Course Title**	**T**	**P**		**Course No.**	**Course Title**	**T**	**P**	A lengthy combination of two courses (Fluid Mechanics & Mechanical/ Particle Operations). BOS proposes to split the two courses as in many other reputed universities like IITs, NITs etc.
CE 4.1	Mathematics-III / Probability and Statistics	4	-		CE 4.1	Mathematics-III / Probability and Statistics	4	-	
CE 4.2	Electrical Engineering / Mechanics	4	-		CE 4.2	Electrical Engineering / Mechanics	4	-	
CE 4.3	Object Oriented Programming	4	4		CE 4.3	Object Oriented Programming	4	4	
CE 4.4	Technical Report Writing / Structure and Properties of Materials	4	-		CE 4.4	Technical Report Writing / Structure and Properties of Materials	4	-	
CE 4.5	Fluid & Fluid–Particle Operations	4	-		CE 4.5	Fluid Mechanics	4	-	
CE 4.6	Chemical Engineering Thermodynamics	4	-		CE 4.6	Chemical Engineering Thermodynamics	4	-	
F 4.1	Selected Writings of Great Authors (SWGA)-II	2	-		F 4.1	Selected Writings of Great Authors (SWGA)-II	2	-	
	Total	**26**	**04**			**Total**	**26**	**04**	

EXAMINATION SCHEME FOR B. TECH. 3RD YEAR CHEMICAL ENGINEERING

B. Tech. Fifth Semester									Remark
Existing scheme					Proposed scheme				
Course No.	**Course Title**	**T**	**P**		**Course No.**	**Course Title**	**T**	**P**	Changes in theory courses have been proposed here in accordance with other reputed institutes like IITs, NITs etc. Transport Phenomena is shifted to B. Tech. 4th year and replaced with Mechanical Operations due to practicals. Lengthy course Mass Transfer has been divided into Mass Transfer-I (V Sem) & II (VI Sem). Laboratory titles changed. The list of experiments among the Labs has been shuffled to align with courses taught.
CE 5.1	Principles of Management / Economics for Engineers	3	-		CE 5.1	Principles of Management / Economics for Engineers	3	-	
CE 5.2	Computational Methods in Engineering	4	-		CE 5.2	Computational Methods in Engineering	4	-	
CE 5.3	Process Instrumentation & Control	4	-		CE 5.3	Process Instrumentation & Control	4	-	
CE 5.4	Chemical Reaction Engineering-I	4	-		CE 5.4	Chemical Reaction Engineering-I	4	-	
CE 5.5	Transport Phenomena	4	-		CE 5.5	Mechanical Operations	4	-	
CE 5.6	Environmental Pollution Control	4	4		CE 5.6	Environmental Pollution Control	4	-	
CE 5.7	Mass Transfer	4	-		CE 5.7	Mass Transfer-I	4	-	
CE 5.8	Chemical Engineering Lab.-I	-	4		CE 5.8	Environmental & Fuel Lab	-	4	
					CE 5.9	Fluid Mechanics & Mechanical Operations Lab.	-	4	
CE 5.9	Process Simulation Lab.-I	-	4		CE 5.10	Process Simulation Lab.-I	-	4	
F 5.1	Women in Indian Society (WIS) / Parenthood and Family Relations	2			F 5.1	Women in Indian Society (WIS) / Parenthood and Family Relations	2		
	Total	**29**	**12**			**Total**	**29**	**12**	

B. Tech. Sixth Semester									Remark
Existing scheme					Proposed scheme				
Course No.	**Course Title**	**T**	**P**		**Course No.**	**Course Title**	**T**	**P**	Changes in theory courses have been proposed here in accordance with other reputed institutes like IITs, NITs etc. Analytical Techniques has been replaced with Mass Transfer-II and proposed to B. Tech. 4th year as an elective. Analytical Techniques Lab has been replaced. Laboratory titles changed. The list of experiments among the Labs has been shuffled to align with courses taught.
CE 6.1	Economics for Engineers / Principles of Management	3	-		CE 6.1	Economics for Engineers / Principles of Management	3	-	
CE 6.2	Analytical Techniques	4	4		CE 6.2	Mass Transfer-II	4	-	
CE 6.3	Process Design Decisions	4	-		CE 6.3	Process Design Decisions	4	-	
CE 6.4	Optimizations of Chemical Processes	4	-		CE 6.4	Optimizations of Chemical Processes	4	-	
CE 6.5	Chemical Reaction Engineering-II	4	-		CE 6.5	Chemical Reaction Engineering-II	4	-	
CE 6.6	Chemical Technology	4	-		CE 6.6	Chemical Technology	4	-	
CE 6.7	Chemical Engineering Lab.-II	-	4		CE 6.7	Heat & Mass Transfer Lab.	-	4	
					CE 6.8	Reaction Engineering & Process Control Lab	-	4	
CE 6.8	Process Simulation Lab.-II	-	4		CE 6.9	Process Simulation Lab.-II	-	4	
CE 6.9	Seminar	2	-		CE 6.10	Seminar	2	-	
F 6.1	Parenthood and Family Relations / Women in Indian Society (WIS)	2			F 6.1	Parenthood and Family Relations / Women in Indian Society (WIS)	2		
	Total	**27**	**12**			**Total**	**27**	**12**	

EXAMINATION SCHEME FOR B. TECH. 4TH YEAR CHEMICAL ENGINEERING

B. Tech. Seventh Semester									Remark
Existing scheme					Proposed scheme				
Course No.	**Course Title**	**T**	**P**		**Course No.**	**Course Title**	**T**	**P**	NO CHANGE
CE 7.1	University-Industry / Institution Linked B. Tech. Project	25	-		CE 7.1	University-Industry / Institution Linked B. Tech. Project	25	-	
CE 7.2	Reading Elective (Self Study)	2	-		CE 7.2	Reading Elective (Self Study)	2	-	
	Total	**27**	**12**			**Total**	**27**	**12**	

S. No.	Reading Elective (Self Study)
1.	Membrane Separation Technology
2.	Corrosion Engineering
3.	Enzyme Engineering
4.	Renewable Energy Resources
5.	Computer Aided Process Plant Design

B. Tech. Eighth Semester									Remark
Existing scheme					Proposed scheme				
Course No.	**Course Title**	**T**	**P**		**Course No.**	**Course Title**	**T**	**P**	Transport Phenomena (from B. Tech. V Sem) replaced the existing course. The existing course has been shifted to Elective category.
CE 8.1	Process Plant Safety & Hazard Analysis	4	-		CE 8.1	Transport Phenomena	4	-	
CE 8.2	Departmental Elective-I	4	-		CE 8.2	Departmental Elective-I	4	-	
CE 8.3	Departmental Elective-II	4	-		CE 8.3	Departmental Elective-II	4	-	
CE 8.4	Open Elective-I	4	-		CE 8.4	Open Elective-I	4	-	
CE 8.5	Open Elective-II	4	-		CE 8.5	Open Elective-II	4	-	
	Total	**20**	**00**			**Total**	**20**	**00**	

Existing scheme			Proposed scheme		Remark
S. No.	**Elective**		**S. No.**	**Elective**	The two courses have been suggested to add as elective.
1.	Petroleum Refining Technology		1.	Petroleum Refining Technology	
2.	Chemical Plant Simulation		2.	Chemical Plant Simulation	
3.	Biochemical Engineering		3.	Biochemical Engineering	
4.	Polymer Science & Technology		4.	Polymer Science & Technology	
5.	Food Processing & Engineering		5.	Food Processing & Engineering	
6.	Nano-Science & Technology		6.	Nano-Science & Technology	
			7.	Process Plant Safety & Hazard Analysis	
			8.	Analytical Techniques	

PROPOSED SYLLABUS FOR B. TECH. CHEMICAL ENGINEERING

B. TECH. IV SEMESTER: CE 4.5 Fluid & Fluid Particle Operations		
Existing	**Proposed**	**Remark**
CE 4.5 Fluid & Fluid Particle Operations	**CE 4.5 Fluid Mechanics**	Course title changed
Section-A **Fluid properties**: properties of fluids and their classification, Newtonian and Non-Newtonian fluids, nature of turbulence, eddy viscosity, flow in boundary layer. **Basic equations of fluid flow**: derivation and applications of Navier stokes equation, Bernoulli's equation and Hagen-Poiseuille equation. Incompressible flow in pipes and channels: shear stress and skin friction, friction from changes in velocity or direction; flow past immersed objects: normal forces in fluids, forces on submerged bodies, Buoyancy and stability, motion of particles through fluids.	**Section-A** **Introduction:** unit systems, dimensional consistency, dimensionless groups; hydrostatic forces on submerged objects, buoyancy; continuum hypothesis, definition of a fluid. **Fluid properties**: properties of fluids and their classification, Newtonian and Non-Newtonian fluids, types of fluid flow, nature of turbulence, eddy viscosity, flow in boundary layer. **Basic equations of fluid flow**: derivation and applications of Navier stokes equation, Bernoulli's equation and Hagen-Poiseuille equation.	Proposed course has been suggested in alignment with other reputed universities like IITs, NITs, BITS etc. **Yellow text:** added topics of the proposed course, "Fluid mechanics". **Grey text:** corrections/ modifications. **Underlined text:** contents moved to the proposed course "Mechanical Operations". **Flow machinery** is rewritten for better clarity. No change in text & reference books.
Section-B **Flow measurement:** flow measuring devices for chemical plants: orifice meter, nozzle and venture meters, rota-meter, pitot tube, Notche **Flow machinery**: classification and performance of pumps, turbines, compressors, blowers, selection and specification, net positive suction head. Pumping and compressing of chemicals and gases, NPSH and calibration. **Size reduction:** principles of crushing and grinding, determination of mean particle size and size distribution, laws of crushing and grinding, energy required for size reduction, crushing and grinding equipment, closed and open circuit grindings, wet gas meters.	**Section-B** **Incompressible flow**: Flow in pipes and channels: shear stress and skin friction, friction from changes in velocity or direction, application of Bernoulli's equation for fluid friction; flow in thin layers. **Flow past immersed objects**: normal forces in fluids, forces on submerged bodies, motion of single particle through fluid, hindered settling; Flow through bed of solids: packed bed, minimum fluidization velocity.	
Section-C **Screen analysis and size separation**: types of screens, mesh number and size distribution, different type of screening, effectiveness of screen, particle size analysis, separation efficiency and screening equipment. **Solid-Liquid Separation**: Theory of filtration, equations for compressible and incompressible cakes, constant rate and constant pressure filtration, **Filtration equipment**: Press filter, rotary drum and vacuum filter, fiber and fabric filters; sedimentation, classifiers and thickeners, centrifuges-principles and applications. **Solid-Gas Separation**: principles and applications of cyclone separators and electrostatic precipitators.	**Section-C** **Flow measurement:** Flow measuring devices for chemical plants: orifice meter, nozzle, venturi meter, rotameter, pitot tube, notches, Hook's experiment. **Flow machinery**: classification of pumps; Centrifugal pump: cavitation, net positive suction head, characteristic curves, pump scale-up; application of Bernoulli's equation for pump work; Gas moving machinery: fans, blowers and compressors; work done in isothermal & adiabatic compression. **Agitation of liquids**: need; Impellers: propellers, paddles and turbines	

B. TECH. V SEMESTER: CE 5.5 Mechanical Operations		
Existing	**Proposed**	**Remark**
CE 4.5 Fluid & Fluid Particle Operations	**CE 5.5 Mechanical Operations**	Separate course proposed (extracted from the existing course) in alignment with other reputed universities like IITs, NITs, BITS etc. **Underlined text:** extracted contents. **Yellow text:** added topics of the proposed course, "Mechanical Operations". **Grey text:** corrections/ modifications. **Red text**: irrelevant deleted topic. "principles…" comes under "crushing & grinding equipments. "fiber and fabric filters" falls under "filter media". Books replaced.
Section-A **Fluid properties**: properties of fluids and their classification, Newtonian and Non-Newtonian fluids, nature of turbulence, eddy viscosity, flow in boundary layer. **Basic equations of fluid flow**: derivation and applications of Navier stokes equation, Bernoulli's equation and Hagen-Poiseuille equation. Incompressible flow in pipes and channels: shear stress and skin friction, friction from changes in velocity or direction; flow past immersed objects: normal forces in fluids, forces on submerged bodies, Buoyancy and stability, motion of particles through fluids.	**Section-A** **Particle technology**: particle size, sphericity, shape factor, different ways of expressing particle size, particle size distribution, measurement of average particle diameter; Laws of crushing and grinding: energy required for size reduction, work index; Crushing & grinding equipments: jaw crusher, roll crusher, gyratory crusher, ball mill, hammer mill, fluid energy mill; closed and open circuit grindings; Screens: ideal and actual screens, types of screens, mesh number and size distribution, particle size analysis, effectiveness of screen (screen efficiency); Industrial screening equipments: grizzly, gyratory screen, vibrating screen, trammel; Size enlargement: agglomeration.	
Section-B **Flow measurement:** flow measuring devices for chemical plants: orifice meter, nozzle and venture meters, rota-meter, pitot tube, Notche **Flow machinery**: classification and performance of pumps, turbines, compressors, blowers, selection and specification, net positive suction head. Pumping and compressing of chemicals and gases, NPSH and calibration. **Size reduction:** principles of crushing and grinding, determination of mean particle size and size distribution, laws of crushing and grinding, energy required for size reduction, crushing and grinding equipment, closed and open circuit grindings, wet gas meters.	**Section-B** **Solid-Liquid separation**: Filtration: principle of cake filtration, equations for compressible and incompressible cakes, constant pressure filtration & constant rate filtration, filter aid, filter medium, characteristics of filter media; Filtration equipments: filter press, rotary drum and vacuum filter, centrifuges-principles and applications; Gravity based separation: sedimentation, clarifier, classifier, thickener, mineral jig, tabling, flotation, hydro-cyclone.	
Section-C **Screen analysis and size separation**: types of screens, mesh number and size distribution, different type of screening, effectiveness of screen, particle size analysis, separation efficiency and screening equipment. **Solid-Liquid Separation**: Theory of filtration, equations for compressible and incompressible cakes, constant rate and constant pressure filtration, **Filtration equipment**: Press filter, rotary drum and vacuum filter, fiber and fabric filters; sedimentation, classifiers and thickeners, centrifuges-principles and applications. **Solid-Gas Separation**: principles and applications of cyclone separators and electrostatic precipitators.	**Section-C** **Solid-Gas separation**: principle and application of cyclone separator and electrostatic precipitator. **Storage & conveying of solids**: bulk storage, bin storage, hoppers, silos; Conveyors: belt conveyor, chain conveyor, apron conveyor, bucket conveyor, bucket elevator, screw conveyor. **Mixing of solids**: application; Types of mixers: muller mixers, ribbon blender, internal screw mixer, tumbling mixer, kneader, Banbury mixer, pug mill.	
Text Book : 1. McCabe, W.L., Smith, J.C., and Harriott, P., "Unit Operations of Chemical Engineering", 7th ed., McGraw Hill, 2005. **Reference Books :** 1. Coulson, J. H. and Richardson, J.F., Backhurst, J. R., and Harker, J. H.,	**Text Books:** 1. McCabe, W.L., Smith, J.C., and Harriott, P., "Unit Operations of Chemical Engineering", 7th ed., McGraw Hill, 2005. 2. Chemical Engineers Hand Book by R. H. Perry and C. H. Chilton. **Reference Books:**	

2.	"Coulson & Richardson's Chemical Engineering", Vol.2, 5th ed., Asian Books Private Ltd., New Delhi, 2008. Foust, A. S., et al., "Principles of Unit Operations", 2nd Ed., John Wiley, 1985.	**1.** Chemical Engineering Vol. I: Coulson & Richardson, Pergamon Press, 1979. **2.** Momentum transfer operation: S. K. Gupta, 1979.	

B. TECH. V SEMESTER: CE 5.7 Mass Transfer		
Existing	**Proposed**	**Remark**
CE 5.7 Mass Transfer	**CE 5.7 Mass Transfer-I**	Course title changed
Section-A **Fundamental of mass transfer:** Molecular diffusion, fluxes and measurement of diffusivities, application to diffusion in fluid and solid systems (stagnant film, equimolar, counter unsteady state) **Convective and interphase mass transfer:** Mass Treansfer coefficients, Laminar and turbulent flow situations and correlations; Two film theory and overall mass transfer coefficients, penetration and surface renewal theories.	**Section-A** **Diffusion:** Fick,s law of diffusion, molecular and eddy diffusion, calculation of diffusivities in gas and liquid, application to diffusion in fluid and solid systems (stagnant film, equimolar, counter, unsteady state). **Convective mass transfer**: mass Transfer coefficients, laminar and turbulent flow situations and correlations. **Inter-phase mass transfer**: film theory, two film theory, penetration and surface renewal theories.	Proposed course has been suggested in alignment with other reputed universities like IITs, NITs, BITS etc. **Yellow text:** added topics of the proposed course, "Mass Transfer-I". **Grey text:** corrections/ modifications. **Underlined text:** contents moved to the proposed course "Mass Transfer-II". **Red text**: deleted topic. Design related topics have been removed. Such topics are covered in details in the M. Tech. course "2.4 Advanced Mass Transfer". Na changes in text and reference books.
Section-B **Continuous contacting Operations:** Gas absorption-countercurrent isothermal, HETP design equation, (L/G) min, NTU, HTU calculation of NTU, nonisothermal absorption co-current operation, packed tower distillation, moving bed adsorbers. **Binary Distillation:** Ideal and non ideal stages definition of point, stage and column efficiencies; Single stage calculations: differential (Rayleigh) and simple (flash) distillation, steam distillation; McCabe-Thiele diagram; plate calculations, feed plate location, simple and complex fractionators. Ponchon-Savarit Diagram: Adiabatic and non- adiabatic.	**Section-B** **Gas absorption**: tray and packed columns, choice of solvent and packing arrangements, countercurrent isothermal, HETP design equation, (L/G) min, NTU, HTU calculation of NTU, nonisothermal absorption co-current operation. **Adsorption**: types of adsorption, nature of adsorbents, Adsorption equilibria: adsorption isotherms and hysteresis; stage wise and continuous contact operations, fixed and moving bed absorbers, adsorption equipments, ion exchange.	
Section-C Liquid- Liquid extraction; adsorption and leaching: batch leaching Gas-liquid and Liquid-Liquid plate Contactors: Flooding, tray layout, p, tray hydradulics, column height and overall design; Flashing equipment design, Multi-component distillations, Azeotropic and extractive distillation, variable specification and key components. cooling towers, Drying theory; crystallization.	**Section-C** **Humidification**: vapor–liquid equilibrium, enthalpy for pure substances, Vapour-gas mixtures: absolute humidity, dry bulb temperature, relative and % saturation, dew point, humid volume, humid heat, adiabatic saturation curves, wet bulb temperature; adiabatic gas-liquid contact operation, classification of cooling towers, dehumidification operation. **Drying**: solid-gas equilibria, different modes of drying operations, definition of moisture, mechanism and rate of batch and continuous drying, batch and continuous driers.	

M. TECH. II SEMESTER: CE 2.4 ADVANCED MASS TRANSFER

Section-C

Design of multicomponent systems: Design of multicomponent distillation column using Lewis-Matheson method, azeotropic and extractive distillation, reactive multistage separations, diffusion in non-ideal system and development of generalized Maxwell-Stefan formulation, Study of generalized Fick,s law.

B. TECH. V SEMESTER: CE 6.2 Mass Transfer-II		
Existing	**Proposed**	**Remark**
CE 5.7 Mass Transfer	**CE 6.2 Mass Transfer-II**	Separate course proposed (extracted from the existing course) in alignment with other reputed universities like IITs, NITs, BITS etc. **Yellow text:** added topics of the proposed course, "Mass Transfer-II". **Grey text:** corrections/ modifications. **Underlined text:** extracted contents. **Red text**: deleted topic. Design related topics have been removed. Such topics are covered in the M. Tech. course "2.4 Advanced Mass Transfer". No changes in text and reference books.
Section-A **Fundamental of mass transfer:** Molecular diffusion, fluxes and measurement of diffusivities, application to diffusion in fluid and solid systems (stagnant film, equimolar, counter unsteady state) **Convective and interphase mass transfer:** Mass Treansfer coefficients, Laminar and turbulent flow situations and correlations; Two film theory and overall mass transfer coefficients, penetration and surface renewal theories.	**Section-A** **Distillation**: Vapor-liquid equilibria: pressure-temperature-concentration phase diagram, enthalpy-concentration diagram; ideal and non-ideal solutions, Raoult's law and its application, relative volatility, maximum and minimum boiling mixtures. **Single stage binary distillation**: flash vaporization, partial condensation, differential (Rayleigh) distillation, differential condensation, constant relative volatility, lever rule, steam distillation.	
Section-B **Continuous contacting Operations:** Gas absorption-countercurrent isothermal, HETP design equation, (L/G) min, NTU, HTU calculation of NTU, nonisothermal absorption co-current operation, packed tower distillation, moving bed adsorbers. **Binary Distillation:** Ideal and non ideal stages definition of point, stage and column efficiencies; Single stage calculations: differential (Rayleigh) and simple (flash) distillation, steam distillation; McCabe-Thiele diagram; plate calculations, feed plate location, simple and complex fractionators. Ponchon-Savarit Diagram: Adiabatic and non- adiabatic.	**Section-B** **Continuous distillation of binary mixtures**: ideal and non-ideal stages, definition of a point, stage and column efficiency; Ponchon Savarit method: adiabatic & non-adiabatic; McCabe Thiele method: plate calculations, feed plate location; use of open steam, tray efficiency, tray type (bubble cap, sieve & valve), flooding, tray layout, delta P, tray hydraulics, determination of column height and diameter; packed column. **Liquid-liquid extraction**: principle, usefulness, ternary liquid equilibria, triangular coordinates, mixer rule, choice of solvent; Extractors: mixer settlers, spray & packed column, rotating disk contactor, sieve tray column.	
Section-C Liquid- Liquid extraction; adsorption and leaching: batch leaching Gas-liquid and Liquid-Liquid plate Contactors: Flooding, tray layout, p, tray hydradulics, column height and overall design; Flashing equipment design, Multi-component distillations, Azeotropic and extractive distillation, variable specification and key components. cooling towers, Drying theory; crystallization.	**Section-C** **Leaching**: solid liquid equilibrium; Batch and continuous operations: single and multistage cross current and counter current operations, number of equilibrium stages; Equipments: percolation tank, agitated vessel, thinkers, classifiers, continuous counter current decantation. **Crystallization**: nucleation & crystal growth rate, controlled growth of crystals, equilibrium yield of crystallization, heat and mass transfer rates in crystallization, classification of industrial crystallizers.	

B. TECH. V SEMESTER: CE 5.6 Environmental Pollution Control Lab		
Existing	**Proposed**	**Remark**
CE 5.6 Environmental Pollution Control Lab.	**CE 5.8 Environmental and Fuel Lab.**	Lab title changed
1. Conductivity of Water **2.** Determination of pH for different water sources/ Samples **3.** Determination of TDS of Water **4.** Available Chlorine **5.** COD **6.** BOD **7.** Composition Analysis of Sample (coal) through Muffle Furnace **8.** Determination of DO through aeration unit **9.** Noise Pollution Measurement **10.** Study of Air Pollution Analysis	**Environmental Pollution Control** **1.** pH and TDS measurement for water samples **2.** Available chlorine **3.** COD measurement **4.** BOD measurement **5.** DO measurement through aeration unit **6.** Air pollution measurement **7.** Noise pollution measurement **Fuel Analysis** **8.** Coal sample analysis **9.** Bomb calorimeter **10.** Carbon residue **11.** Smoke point analysis **12.** Flash point measurement **13.** Orsat gas analysis **14.** Reid vapor pressure **Note**: Minimum five experiments from each subject are compulsory.	**Red text**: deleted experiment. **Yellow text**: new experiments proposed to replace "CE 6.2 Analytical Techniques Lab." course. **Grey text**: correction / modification

B. TECH. V SEMESTER: CE 5.8 Chemical Engineering Lab.-I		
Existing	**Proposed**	**Remark**
CE 5.8 Chemical Engineering Lab.-I	**CE 5.9 Fluid Mechanics & Mechanical Operations Lab.**	Lab title changed
(Heat Transfer, Fluid and Fluid-Solid Operations and Chemical Reaction Engineering) **1.** Isothermal batch reactor **2.** Continuous stirred tank reactor **3.** Plug flow reactor (coil type) **4.** Plug flow reactor (straight tube) **5.** Fin tube heat exchanger **6.** Shell and Tube heat exchanger **7.** Vertical and horizontal condenser **8.** Pressure drop due to various kind of fittings **9.** Pressure drop due to frictional losses **10.** Centrifugal pump test rig (constant speed) **11.** Centrifugal pump test rig (variable speed) **12.** Ball mill (constant speed) **13.** Ball mill (variable speed) **14.** Roll crusher **15.** Jaw crusher **16.** Gyratory sieve shaker with test sieve	**Fluid Mechanics** **1.** Pressure drop due to various kind of fittings ***2.*** *Drag coefficient measurement* **3.** Bernoulli's theorem **4.** Flow measurement through pressure drop **5.** Fluidized bed **6.** Centrifugal pump test rig (constant speed) **7.** Centrifugal pump test rig (variable speed) **Mechanical Operations** **8.** Gyratory sieve shaker with test sieves **9.** Ball mill (constant speed) **10.** Ball mill (variable speed) **11.** Roll crusher **12.** Jaw crusher **13.** Cyclone separator **14.** Mineral Jig **Note**: Minimum five experiments from each subject are compulsory.	**Red text**: deleted experiment. Exp. 9: deleted, setup not available. **Yellow text**: new experiments **Grey text**: correction / modification **Underline text**: experiment shifted to other BTech VI Semester Labs. **Italic text**: experiment brought from BTech VI Semester Lab.

B. TECH. V SEMESTER: CE 6.7 Chemical Engineering Lab.-II		
Existing	**Proposed**	**Remark**
CE 6.7 Chemical Engineering Lab.-II	**CE 6.7 Heat & Mass Transfer Lab.**	Lab title changed
(Mass Transfer, Reaction Engineering and Process Control) **1.** Steam distillation **2.** Continuous packed bed distillation **3.** Drag coefficient system **4.** Forced draft tray dryer **5.** Solid-gas diffusion **6.** Adsorption in packed bed **7.** Vapor-liquid equilibria **8.** Liquid-liquid extraction **9.** Rotary vacuum filter **10.** RTD studies in plug flow reactor (coiled type) **11.** Heat transfer in agitated vessel **12.** Time constant of thermocouple and thermometer **13.** Time constant of manometer **14.** Trainer for temperature control **15.** Trainer for pressure control **16.** Trainer for level control **17.** Trainer for flow control	**Heat Transfer** ***1.*** *Fin tube heat exchanger* ***2.*** *Shell and Tube heat exchanger* ***3.*** *Vertical and horizontal condenser* **4.** Heat transfer in agitated vessel **5.** Heat Transfer through composite wall **6.** Natural convection heat transfer **7.** Forced Convection heat transfer **Mass Transfer** **8.** Steam distillation **9.** Continuous packed bed distillation **10.** Forced draft tray dryer **11.** Solid-gas diffusion **12.** Adsorption in packed bed **13.** Vapor-liquid equilibria **14.** Liquid-liquid extraction **Note**: Minimum five experiments from each subject are compulsory.	**Red text**: deleted experiment. Exp. 9: deleted, being conducted for M. Tech. students. Data collection requires time and careful handling, **Yellow text**: new experiments **Grey text**: correction / modification **Underline text**: experiment shifted to other BTech V & VI Semester Labs. **Italic text**: experiment brought from BTech V Semester Lab.

B. TECH. V SEMESTER: CE 6.2 Analytical Techniques Lab.		
Existing	**Proposed**	**Remark**
CE 6.2 Analytical Techniques Lab.	**CE 6.9 Reaction Engineering & Process Control Lab.**	Lab title changed
1. Conductometric Technique: **1.1** To determine the strength of the given acid conductometrically using standard alkali solution. **1.2** To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically. **1.3** To study the saponification of ethyl acetate conductometrically. **1.4** To determine the ionization constant of a weak acid conductometrically. **2. Colorimetric Technique:** To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given solution of the substance. **3. Potentiometric Technique:** To titrate potentiometrically the given ferrous ammonium sulphate solution using $KMnO_4/K_2Cr_2O_7$ as titrant and calculate the redox potential of Fe^{2+}/Fe^{3+} on system on the hydrogen scale. **4. pH metric Technique:** Determine the pH values of various mixtures of CH_3COONa and CH_3COOH in aqueous solution and hence find out the dissociation constant of the acid. **5. Chromatographic techniques:** **5.1** Separation of binary organic mixture by column chromatography. **5.2** Separation of metals by paper chromatography. **5.3** Separation of fluorescent materials by thin layer chromatography.	**Reaction Engineering** **1.** Study of rate law parameters **2.** Reactors in series ***3.*** *Isothermal batch reactor* ***4.*** *Continuous stirred tank reactor* ***5.*** *RTD studies in plug flow reactor* ***6.*** *Plug flow reactor (coil type)* ***7.*** *Plug flow reactor (straight tube)* **Process Control** **8.** Interacting and non-interacting systems ***9.*** *Time constant of thermocouple and thermometer* ***10.*** *Time constant of manometer* ***11.*** *Trainer for temperature control* ***12.*** *Trainer for pressure control* ***13.*** *Trainer for level control* ***14.*** *Trainer for flow control* **Note**: Minimum five experiments from each subject are compulsory.	**Red text**: deleted experiment. **Yellow text**: new experiments **Grey text**: correction / modification **Italic text**: experiment brought from BTech V & VI Semester Labs.

No changes have been proposed in M. Tech. 1st year examination scheme.

EXAMINATION SCHEME FOR M. TECH. 2ND YEAR CHEMICAL ENGINEERING

M. Tech. Third and Fourth Semesters				Remark
Existing Scheme		**Proposed Scheme**		
Components	**Marks**	**Components**	**Marks**	**Red text**: deleted component. **Grey text**: correction / modification. Changes have been proposed to align existing scheme with other departments at Banasthali. Note given below should be written with examination scheme.
A. Dissertation		**A. Dissertation**		
Part I: Interim submission		**Part I**: Interim submission		
i. Report	60	i. Report	100	
ii. Presentation	60	ii. Presentation	100	
iii. Viva-voce	40	iii. Viva-voce	100	
Part II: Complete submission		**Part II**: Complete submission		
i. Report	100	i. Report	125	
ii. Presentation	100	ii. Presentation	125	
iii. Viva-voce	100	iii. Viva-voce	100	
Sub-Total (**A**)	**460**	Sub-Total (**A**)	**650**	
B. Project		**B. Reading Elective-I**	**40**	
i. Report	60	**C. Reading Elective-II**	**40**	
ii. Presentation	60	Total (**A** + **B** + **C**)	**730**	
iii. Viva-voce	40			
Sub-Total (**B**)	**160**			
C. Seminar	**30**			
D. Reading Elective-I	**40**			
E. Reading Elective-II	**40**			
Total (**A** + **B** + **C** + **D** + **E**)	**730**			

Note: Students will register for one course under **Reading Elective-I** in **III** semester and one course under **Reading Elective-II** in **IV** semester from the list of courses given below.

Reading Elective-I	**Reading Elective-II**
Green Energy	Safety in Process Industry
Life Cycle Assessment	Water and Land Pollution
ISO Practices in Industry	Social Responsibilities of Industries

PROPOSED SYLLABUS FOR M. TECH. CHEMICAL ENGINEERING

M. TECH. I SEMESTER: CE 1.2 Equipment Design		
Existing	**Proposed**	**Remark**
Section-C **Design of Mechanical Separation Equipment**: Guide to Gas-Solid Separator design: centrifugal separator, sedimentation. **Process Hazards and Safety Measures in Equipment Design**: process hazards, hazard identification, risk analysis, pressure relief devices.	**Section-C** **Design of Mechanical Separation Equipment**: Guide to gas-solid separator design: cyclone separator, Guide to liquid-solid separator design: vertical and horizontal separator. **Process Hazards and Safety Measures in Equipment Design**: process hazards, hazard identification, risk analysis, pressure relief devices.	The text "centrifugal" is working principle for "cyclone" equipment. Sedimentation is liquid-solid separation process. Text has been modified to specify the types of equipment involved.

M. TECH. I SEMESTER: CE 1.3 Advanced Reaction Engineering		
Existing	**Proposed**	**Remark**
Section-A **Heterogeneous Catalysis and Catalytic Processes**: characterization of catalysts (engineering properties of catalysts, BET surface area, pore volume, pore size, pore size distribution, n2 adsorption method, mercury helium method, BET isotherm), physical and chemical adsorption, steps in catalytic reaction (adsorption, kinetic models), mechanism of catalytic reactions, determination of rate expressions using adsorption, surface reaction and desorption as rate controlling step, determination of rate of reaction from experimental data, preparation of catalysts.	**Section-A** **Heterogeneous Catalysis and Catalytic Processes**: characterization of catalysts: engineering properties of catalysts, BET surface area, pore volume, pore size, pore size distribution, n2 adsorption method, mercury helium method, BET isotherm; physical and chemical adsorption, steps in catalytic reaction. **Mechanism of Catalytic Reactions**: Langmuir-Hinshelwood and Eley-Rideal mechanisms, determination of rate expressions using adsorption, surface reaction and desorption as rate controlling step, determination of rate of reaction from experimental data, preparation of catalysts.	**Red text**: deleted topic **Grey text**: correction / modification **Yellow text**: added topic The text, "adsorption, kinetic models" is covered under "Mechanism of Catalytic Reactions".
Section-C **Gas-Liquid Reactions on solid catalyst and Packed bed catalytic reactors:** trickle bed, slurry reactors, three-phase fluidized beds, general rate equations & performance equations, Design of fixed bed catalytic reactor, isothermal, adiabatic, non-isothermal reactors: one dimensional, two dimensional approaches.	**Section-C** **Gas-Liquid Reactions on solid catalyst and Packed bed catalytic reactors:** trickle bed, slurry reactors, three-phase fluidized beds, general rate equations & performance equations. **Design of fixed bed catalytic reactor**: isothermal, adiabatic, non-isothermal reactors: one dimensional, two dimensional approaches.	

M. TECH. II SEMESTER: CE 2.2 Energy Conservation		
Existing	**Proposed**	**Remark**
Section-A **Introduction**: Energy generation, utilization, economics and growth rates, ENCON: approach, modern techniques, benefits, trends, energy conservation in energy intensive industries: boilers, steam system, heating systems, furnaces. **Energy efficiency**: Energy accounting, overview of energy audit, monitoring and control.	**Section-A** **Introduction**: Energy generation, utilization, economics and growth rates, ENCON: approach, modern techniques, benefits, trends, energy conservation in energy intensive industries: boilers, steam system, heating systems, furnaces. **Energy efficiency**: Energy accounting; Overview of energy audit, monitoring and control.	**Grey Text**: correction / modification.

M. TECH. II SEMESTER: CE 2.4 Process and Product Development		
Existing	**Proposed**	**Remark**
Section-A **Introduction**: goal of industrial research and development, production structure of chemical industry, task of process development, creative thinking. preliminary database creation, preliminary process synthesis, examples. **Product Development**: development of chemical product on laboratory scale, quality improvement, reproducibility etc. case studies of products developed. **Chemical Production Plant and Its Components**: details about catalyst, reactors, product processing, pipelines pumps and compressors, product supply and storage, water disposal, measurement and control technology, plant safety, material selection.	**Section-A** **Introduction**: goal of industrial research and development, production structure of chemical industry, task of process development, creative thinking, preliminary database creation, preliminary process synthesis, examples. **Product Development**: development of chemical product on laboratory scale, quality improvement, reproducibility etc. Case studies of products developed. **Chemical Production Plant and Its Components**: about catalyst, reactors, product processing, pipelines pumps and compressors, product supply and storage, water disposal, measurement and control technology, plant safety, material selection.	**Red Text**: deleted text. The word "details" has been removed to avoid confusion.

M. TECH. II SEMESTER: CE 2.5 Fluidization Technology		
Existing	**Proposed**	**Remark**
Section-A **Introduction**: the phenomenon of fluidization, liquid like behavior of a fluidized bed, comparison with other contacting methods, advantages and disadvantages of fluidized beds for industrial operations, fluidization quality, selection of a contacting mode for a given application. **Industrial applications of fluidized beds**: coal gasification, gasoline from other petroleum fractions, gasoline from natural and synthesis gases, synthesis reactions, metallurgical and other processes, physical operations, synthetic reactions, cracking of hydrocarbons, combustion and incinerations, carbonization and gasification, calcination, biofluidization. **Mapping of regimes and dense bed**: fixed bed of particles, fluidization without carryover of particles, types of fluidization without carryover, fluidization with carryover, mapping of regimes, distributor types, gas entry regions, gas jet region, design of gas distributors, power consumption.	**Section-A** **Introduction**: the phenomenon of fluidization, liquid like behavior of a fluidized bed, comparison with other contacting methods, advantages and disadvantages of fluidized beds, fluidization quality, selection of a contacting mode for a given application. **Industrial applications of fluidized beds**: coal gasification, gasoline from other petroleum fractions, synthesis reactions, metallurgical and other processes, physical operations, synthetic reactions, cracking of hydrocarbons, biofluidization. **Mapping of regimes and dense bed**: fixed bed of particles, fluidization without carryover of particles, mapping of regimes, distributor types, gas entry regions, gas jet region.	The existing course is too big to cover hence syllabus has been reduced while keeping it in alignment with other reputed universities like BITS, IITs, NITs etc. **Red text**: deleted topic. **Grey text**: corrected / modified text.
Section-B **Bubbles in the fluidized bed**: single rising bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slag flow, bubbling bed: estimation of bed properties, physical models for bubbling bed, flow model for bubbling bed, two phase model, K-L model. **Entrainment and elutriation from fluidized beds**: freeboard behavior, location of the gas outlet of a vessel, Entrainment of tall vessel: the elutriation constant approach, relationship between k and Gs, experimental findings of k and k*, entrainment from short vessel, freeboard entrainment model. **High velocity fluidization**: turbulent fluidized beds, fast fluidization, application of freeboard entrainment model, pressure drop in fast and turbulent fluidization. **Mixing, segregation and staging**: vertical and horizontal movements of solids, segregation of particles, large solids in small beds, staging of fluidized bed.	**Section-B** **Bubbles in the fluidized bed**: single rising bubbles, coalescence and splitting of bubbles, flow model for bubbling bed, two phase hypothesis. **Entrainment and elutriation from fluidized beds**: freeboard behavior, location of the gas outlet of a vessel, Entrainment of tall vessel: the elutriation constant approach, relationship between k and Gs, experimental findings of k and k*, K-L approach. **High velocity fluidization**: turbulent fluidized beds, fast fluidization. **Mixing, segregation and staging**: vertical and horizontal movements of solids, segregation of particles.	
Section-C **Mass and heat transfer in fluidized bed:** dispersion of gas in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient, mass transfer between particle and bed, heat transfer between fluidized bed and surfaces. **Circulation system:** circuits for the circulation of solids, circulation rates, flow of gas-solid mixture in down-comers, flow of pneumatic transport lines. **Design of fluidized bed reactors:** design of	**Section-C** **Mass and heat transfer in fluidized bed:** dispersion of gas in beds, gas interchange between bubble and emulsion, mass transfer between particle and bed, heat transfer between fluidized bed and surfaces. **Circulation system:** circuits for the circulation of solids, circulation rates, flow of gas-solid mixture in down-comers. **Fluidized bed reactor:** reaction rates and reactor performance, reactor model for fine particle bubbling bed, intermediate and large	

physical operators: heat transfer, mass transfer, drying of solids. design of catalytic reactors: batch scale reactors, pilot plant reactors, design decisions, deactivating catalysis. design of non-catalytic gas solid reactors: kinetic models for the conversion of solids, conversion of solids with unchanging sizes, conversion of shrinking and growing particles.	size particle beds.	

Verified

Offg. Secretary
Banasthali Vidyapith
P.O. Banasthali Vidyapith
Distt. Tonk (Raj.)-304022

Department of Chemical Engineering
BanasthaliVidyapith, Banasthali, Rajasthan, India-304022

Minutes of Board of Studies Meeting held on 27th December 2018 in the CMS Conference Hall of BbanasthaliVidyapith.

Present

1.	Prof. S. P. Chaurasia	:	External Member
2.	Prof. K. K. Pant	:	External Member
3.	Prof. J. K. Shrivastava	:	External Member
4.	Dr. Somen Jana	:	Internal Member
5.	Mr. Ashok Kumar Yadav	:	Internal Member
6.	Mr. Deepak Kumar	:	Internal Member
7.	Ms. PriyankaBisht	:	Internal Member
8.	Ms. Meenakshi	:	Internal Member
9.	Mr. Sandeep Kumar Patel	:	Internal Member
10.	Mr. Saurabh Joshi	:	Internal Member
11.	Ms. VibhaVerma	:	Internal Member
12.	Dr. Gaurav Kumar	:	Internal Member
13.	Dr. SatishShukla	:	Internal Member
14.	Dr. B. R. Naratajan	:	Convener

Note: Prof. S. P. Chaurasia, MNIT Jaipur, Prof. K. K. Pant, IIT Delhi, Prof. J. K. Shrivastava, GEC Ujjain (External Members) and Dr. B. R. Naratajan (Convener) could not attend the meeting.

The meeting started with a welcome of the members, by Dr. SatishShukla of Department of Chemical Engineering,BanasthaliVidyapith, Rajasthan.

1. The board took up the minutes of its last meeting held on April, 23, 2016.

   The Board resolved that the minutes to be confirmed.
2. The board reviewed the existing panel of examiners and suggested to update the address and phone numbers of the existing examiners for each examination up to and inclusive of all Master's degree examination keeping in view the by-law 15.03.02 of the Vidyapith. Updated panel is sent to the secrecy section by the HOD of the Department.
3. The board reviewed the courses of study, curricula and scheme of examinations of the following Examinations:

   3 I B.Tech. in Chemical Engineering

i	First Semester Examination, December, 2019	No Change
ii	Second Semester Examination, April/May, 2020	No Change
iii	Third Semester Examination, December, 2020	No Change
iv	Fourth Semester Examination, April/May, 2021	No Change

v	Fifth Semester Examination, December, 2021	Change[(a), (b), (c), (d)]
vi	Sixth Semester Examination, April/May, 2022	Change[(e)]
vii	Seventh Semester Examination, December, 2022	No Change
viii	Eight Semester Examination, April/May, 2023	Change[(f), (g), (h)]

The Board reviewed the examination schemes and syllabi of the BTechProgrammeas listed aboveand proposed a reduction in credit. The details are as follows.

(a) The board has proposed two new courses (Course Choice-3/5; Numerical Methods/Probability & Statistics) which will run alternatively in BTechV and VI semesters in all BTechprogrammes.

(b) CE 5.3 Computational Methods in Engineering course has been removed considering the proposed course (Numerical Methods) under Course Choice-3 which is common to all BTechprogrammes.

(c) CE 5.2 Chemical Reaction Engineering course has been shifted from V semester to VI semester.

(d) CE 5.5 Environmental Pollution Control course has been shifted to BTechVIII semester.

(e) Three courses (CE 6.2 Advanced Chemical Reaction Engineering, CE 6.4 Optimization of Chemical Processes and CE 6.8 Advanced Mass Transfer) have been shifted to elective category in BTechVIII semester.

(f) In BTechVIII semester examination scheme will consist of two elective courses (which can be either open or disciplinary) and three compulsory courses.

(g) In BTechVIII semester Chemical Plant Simulation course has been shifted from elective to compulsory course.

(h) In BtechVIII semester there are now thirteen elective courses. Added elective courses are Advanced Heat Transfer, Advanced Chemical Reaction Engineering, Advanced Mass Transfer, Optimization of Chemical Processes, Analytical Techniques, Robotics and Automation, Artificial Intelligence and Cloud Computing.

ProgrammeEducational Objectives, Programme Outcomes and Examination Schemesis attached and marked as **Annexure-I(A)**.

No changes in BTech Chemical Engineering syllabi have been proposed. Learning Outcomes, suggested e-resources for the courses is attached and marked as **Annexure-II(A)**.

3 II M.Tech. in Chemical Engineering

i	First Semester Examination, December, 2019	Change[(a)]
ii	Second Semester Examination, April/May, 2020	No Change
iii	Third Semester Examination, December, 2020	No Change
iv	Fourth Semester Examination, April/May, 2021	No Change

The Board reviewed the examination schemes and syllabi of the MTechProgramme as listed above. The details are as follows.

(a) The course (CHE 506 Advanced Reaction Engineering) has been replaced with the exiting course (CHE 304 Advanced Chemical Reaction Engineering) as content of these courses are mostly identical.

Programme Educational Objectives, Programme Outcomes and Examination Schemes is attached and marked as **Annexure-I(B)**.

Learning Outcomes, suggested e-resources for the courses is attached and marked as **Annexure-II(B)**.

4. The Board reviewed the curriculum for the courses running in other programmes of the Vidypaith and proposed no change in the syllabus of the existing courses.

1	CHE 101 Thermodynamics	No Change
2	ENGG 201Structure and Properties of Materials	No Change

5. The Board received and reviewed the reports of examiners of third, fourth, fifth and sixth semester B.Tech. (Chemical Engineering) examinations 2016-2018 and first, second, third and forth semesters of MTech Chemical Engineering examinations 2016-18. All reports were found to be satisfactory.
6. The board critically analyzed the question papers of third, fourth, fifth, sixth, seventh and eighth semester of B.Tech. Chemical Engineering 2013-18 as well as first, second, third and fourth semester examinations of M. Tech. Chemical Engineering of 2013-18 and observed that all the question papers were balanced on the basis of desired parameters (Analytical, Descriptive, Thought provoking and Application based) and considering the nature of individual courses.

BOS was concluded with a vote of thanks to all the members.

Programme & Course Format for BOS Minutes

Name of the Programme: BTech (Chemical Engineering)

Programme Educational Objectives:

- To develop latitude of effectiveness in applying chemical engineering principles in engineering practice or for advanced study in chemical engineering, medicine, law, business and social work.
- To develop longitude of not only opening careers in the branch of study as well as interdisciplinary and multidisciplinary fields such as pharmaceuticals, microelectronics, chemicals, polymers/advanced materials, food processing, energy, biotechnology and environmental engineering.
- To develop altitude of professionalism to function effectively in the complex modern work environment, both as individuals as well as in team, with the ability to assume leadership roles and achieve understanding and appreciation of ethical behavior, social responsibility and diversity.

Programme Outcomes: Each graduate will be able to

- have an education that is supportive of a broad awareness of the diversity of the world and its cultures, and that provides an understanding of the impact of engineering practice in the global, economic, environmental, and societal context.
- demonstrate a working knowledge, including safety and environmental aspects, of material and energy balances applied to chemical processes; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transport; chemical reaction engineering; continuous and stage wise separation operations; process dynamics and control; and chemical engineering design.
- have the ability to apply knowledge of mathematics, science and engineering to analyze and interpret data and design and conduct experiments safely, as well as the ability to design a process that meets desired specifications with consideration of environmental, safety, economic and ethical criteria.
- ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- have the ability to communicate effectively in written, oral, and graphical forms as well as work as a member of multidisciplinary teams, and have an understanding of team leadership
- have knowledge of contemporary issues and will recognize the need for and have the ability to engage in lifelong learning.

Programme Scheme:

Semester: I

Existing Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
BVF 002	Environmental Studies	2	0	0	2
	Or				
BVF 003	Indian Heritage	2	0	0	2
MATH 103	Calculus	3	1	0	4
	Or				
Math 107	Linear Algebra	3	1	0	4
PHY 101	Applied Optics	3	1	0	4
	Or				
PHY106	Modern Physics	3	1	0	4
CHEM 101	Chemistry	3	1	0	4
	Or				
BIO 101	Biology	3	1	0	4
CHE 101	Thermodynamics	3	1	0	4
	Or				
PHY 105	Engineering Mechanics	4	0	0	4
CS 109	Computer Fundamentals and Programming	4	0	0	4
CS 109L	Computer Fundamentals and Programming Lab	0	0	4	2
	Or				
EEE 101	Electrical Engineering	4	0	0	4
EEE 101L	Electrical Engineering Lab	0	0	4	2
ENGG 101L	Engineering Drawing and Graphics Lab	0	0	6	3
	Or				
ENGG 102L	Measurement Techniques Lab	0	0	6	3
	Total	19	4	10	27

Proposed Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Environmental Studies	2	0	0	2
	Or				
	Indian Heritage	2	0	0	2
	Calculus	3	1	0	4
	Or				
	Linear Algebra	3	1	0	4
	Applied Optics	3	1	0	4
	Or				
	Modern Physics	3	1	0	4
	Chemistry	3	1	0	4
	Or				
	Biology	3	1	0	4
	Thermodynamics	3	1	0	4
	Or				
	Engineering Mechanics	4	0	0	4
	Computer Fundamentals and Programming	4	0	0	4
	Computer Fundamentals and Programming Lab	0	0	4	2
	Or				
	Electrical Engineering	4	0	0	4
	Electrical Engineering Lab	0	0	4	2
	Engineering Drawing and Graphics Lab	0	0	6	3
	Or				
	Measurement Techniques Lab	0	0	6	3
	Total	19	4	10	27

Course details: (See **Annexure II(A)**)

Semester: II

Existing Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
BVF 003	Indian Heritage	2	0	0	2
	Or				
BVF 002	Environmental Studies	2	0	0	2
Math 107	Linear Algebra	3	1	0	4
	Or				

Proposed Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Indian Heritage	2	0	0	2
	Or				
	Environmental Studies	2	0	0	2
	Linear Algebra	3	1	0	4
	Or				

MATH 103	Calculus	3	1	0	4		Calculus	3	1	0	4
PHY106	Modern Physics	3	1	0	4		Modern Physics	3	1	0	4
	Or						Or				
PHY 101	Applied Optics	3	1	0	4		Applied Optics	3	1	0	4
BIO 101	Biology	3	1	0	4		Biology	3	1	0	4
	Or						Or				
CHEM	Chemistry	3	1	0	4		Chemistry	3	1	0	4
PHY 105	Engineering Mechanics	4	0	0	4		Engineering Mechanics	4	0	0	4
	Or						Or				
CHE 101	Thermodynamics	3	1	0	4		Thermodynamics	3	1	0	4
EEE 101	Electrical Engineering	4	0	0	4		Electrical Engineering	4	0	0	4
EEE 101L	Electrical Engineering Lab	0	0	4	2		Electrical Engineering Lab	0	0	4	2
	Or						Or				
CS 109	Computer Fundamentals and Programming	4	0	0	4		Computer Fundamentals and Programming	4	0	0	4
CS 109L	Computer Fundamentals and Programming Lab	0	0	4	2		Computer Fundamentals and Programming Lab	0	0	4	2
ENGG 102L	Measurement Techniques Lab	0	0	6	3		Measurement Techniques Lab	0	0	6	3
	Or						Or				
ENGG 101L	Engineering Drawing and Graphics Lab	0	0	6	3		Engineering Drawing and Graphics Lab	0	0	6	3
	Total	**19**	**4**	**10**	**27**		**Total**	**19**	**4**	**10**	**27**

Course details: (See **Annexure II(A)**)

Semester: III

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
BVF 007R	Selected Writings for Self Study-I	2	0	0	2			Selected Writings for Self Study-I	2	0	0	2
	Course Choice-1	3/4	0	0	3/4			Course Choice-1	3	0/1	0	3/4
	Course Choice-2	4	0	0	4			Course Choice-2	3	1	0	4
	Course Choice-3	3	0	0	3			Course Choice-3	3	0	0	3
CHE 202	Chemical Process Calculations	3	1	0	4			Chemical Process Calculations	3	1	0	4
CHE 204	Heat Transfer	3	1	0	4			Heat Transfer	3	1	0	4
CS 209	Data Structures	4	0	0	4			Data Structures	3	1	0	4
CS 209L	Data Structures Lab	0	0	4	2			Data Structures Lab	0	0	4	2
	Total	**22/23**	**2**	**4**	**26/27**			**Total**	**20**	**4/5**	**4**	**26/27**

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Course Choice- 1							**Course Choice- 1**					
MATH 207	Complex Variables	3	0	0	3			Complex Variables	3	0	0	3
MATH 208	Differential Equations	4	0	0	4			Differential Equations	3	1	0	4
Course Choice- 2							**Course Choice- 2**					
ENGG 201	Structure and Properties of Materials	4	0	0	4			Structure and Properties of Materials	3	1	0	4
ENGG 202	Basic Electronics	4	0	0	4			Basic Electronics	3	1	0	4
Course Choice- 3							**Course Choice- 3**					
MGMT 209	Entrepreneurship	3	0	0	3			Entrepreneurship	3	0	0	3
TSKL 203	Technical Report Writing	3	0	0	3			Technical Report Writing	3	0	0	3

Course details:(See **Annexure II(A)**)

Semester: IV

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
BVF 008R	Selected Writings for Self Study-II	2	0	0	2			Selected Writings for Self Study-II	2	0	0	2
	Course Choice-4	4/3	0	0	4/3			Course Choice-4	3	1/0	0	4/3
	Course Choice-5	4	0	0	4			Course Choice-5	3	1	0	4
	Course Choice-6	3	0	0	3			Course Choice-6	3	0	0	3
CHE 201	Chemical Engineering Thermodynamics	3	1	0	4			Chemical Engineering Thermodynamics	3	1	0	4
CHE 203	Fluid Mechanics	3	1	0	4			Fluid Mechanics	3	1	0	4
CS 214	Object Oriented Programming	4	0	0	4			Object Oriented Programming	3	1	0	4
CS 214L	Object Oriented Programming Lab	0	0	4	2			Object Oriented Programming Lab	0	0	4	2
	Total	**23/22**	**2**	**4**	**27/26**			**Total**	**20**	**5/4**	**4**	**27/26**

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Course Choice- 4							**Course Choice- 4**					
MATH 208	Differential Equations	4	0	0	4			Differential Equations	3	1	0	4
MATH 207	Complex Variables	3	0	0	3			Complex Variables	3	0	0	3
Course Choice- 5							**Course Choice- 5**					
ENGG 202	Basic Electronics	4	0	0	4			Basic Electronics	3	1	0	4
ENGG 201	Structure and Properties of Materials	4	0	0	4			Structure and Properties of Materials	3	1	0	4
Course Choice- 6							**Course Choice- 6**					
TSKL 203	Technical Report Writing	3	0	0	3			Technical Report Writing	3	0	0	3
MGMT 209	Entrepreneurship	3	0	0	3			Entrepreneurship	3	0	0	3

Course details: (See **Annexure II(A)**)

Semester: V

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
FC 5.1	Course Choice-1	3	0	0	3			Course Choice-1	3	0	0	3
CE 5.1	Course Choice-2	3	0	0	3			Course Choice-2	3	0	0	3
CE 5.2	Chemical Reaction Engineering	3	1	0	4			Course Choice-3	2/3	1	0	3/4
CE 5.3	Computational Methods in Engineering	3	1	0	4			Mass Transfer	3	1	0	4
CE 5.4	Environmental and Fuel Lab	0	0	4	2			Chemical Process Control	3	1	0	4
CE 5.5	Environmental Pollution Control	3	1	0	4			Mechanical Operations	3	1	0	4
CE 5.6	Mass Transfer	3	1	0	4			Environmental and Fuel Lab	0	0	4	2
CE 5.7	Chemical Process Control	3	1	0	4			Fluid Mechanics and Mechanical Operations Lab	0	0	4	2
CE 5.8	Process Simulation Lab-I	0	0	4	2			Process Simulation Lab-I	0	0	4	2
CE 5.9	Fluid Mechanics and Mechanical Operations Lab	0	0	4	2							
CE 5.10	Mechanical Operations	3	1	0	4							
Total		**24**	**6**	**12**	**36**		**Total**		**17/18**	**4**	**12**	**27/28**

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Course Choice- 1							**Course Choice- 1**					
FC 5.1	Parenthood and Family Relation	3	0	0	3			Parenthood and Family Relation	3	0	0	3
FC 5.1	Women in Indian Society	3	0	0	3			Women in Indian Society	3	0	0	3
Course Choice- 2							**Course Choice- 2**					
CE 5.1	Economics for Engineers	3	0	0	3			Economics	3	0	0	3
CE 5.1	Principles of Management	3	0	0	3			Principles of Management	3	0	0	3
							Course Choice- 3					
								Numerical Methods	2	1	0	3
								Probability and Statistical Methods	3	1	0	4

Course details: (See **Annexure II(A)**)

Semester: VI

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
FC 6.1	Course Choice-3	3	0	0	3			Course Choice-4	3	0	0	3
CE 6.1	Course Choice-4	3	0	0	3			Course Choice-5	3	0	0	3
CE 6.2	Advanced Chemical Reaction Engineering	3	1	0	4			Course Choice-6	3/2	1	0	4/3
CE 6.3	Chemical Technology	3	1	0	4			Chemical Reaction Engineering	3	1	0	4
CE 6.4	Optimization of Chemical Processes	3	1	0	4			Chemical Technology	3	1	0	4
CE 6.5	Plant Design and Economics	3	1	0	4			Plant Design and Economics	3	1	0	4
CE 6.6	Process Simulation Lab-II	0	0	4	2			Heat and Mass Transfer Lab	0	0	4	2
CE 6.7	Seminar	0	2	0	2			Reaction Engineering and Process Control Lab	0	0	4	2
CE 6.8	Advanced Mass Transfer	3	1	0	4			Process Simulation Lab-II	0	0	4	2
CE 6.9	Heat and Mass Transfer Lab	0	0	4	2			Seminar	0	2	0	2
CE 6.10	Reaction Engineering and Process Control Lab	0	0	4	2							
	Total	**21**	**7**	**12**	**34**			**Total**	**18/17**	**6**	**12**	**30/29**

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Course Choice- 3							**Course Choice- 4**					
FC 6.1	Women in Indian Society	3	0	0	3			Women in Indian Society	3	0	0	3
FC 6.1	Parenthood and Family Relation	3	0	0	3			Parenthood and Family Relation	3	0	0	3
Course Choice- 4							**Course Choice- 5**					
CE 6.1	Principles of Management	3	0	0	3			Principles of Management	3	0	0	3
CE 6.1	Economics for Engineers	3	0	0	3			Economics	3	0	0	3
							Course Choice- 6					
								Probability and Statistical Methods	3	1	0	4
								Numerical Methods	2	1	0	3

Course details: (See **Annexure II(A)**)

Semester: VII

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
CE 7.1	Reading Elective	0	2	0	2			Reading Elective	2	0	0	2
CE 7.2	University-Industry/ Institution Linked (UIL) Project	0	25	0	25			University-Industry/ Institution Linked (UIL) Project	0	20	0	20
	Total	**0**	**27**	**0**	**27**			**Total**	**0**	**22**	**0**	**22**

Existing			Proposed	
Reading Elective			**Reading Elective**	
Course Code	**Course Name**		**Course Code**	**Course Name**
CE 7.1	Membrane Separation Technology			Membrane Separation Technology
CE 7.1	Corrosion Engineering			Corrosion Engineering
CE 7.1	Enzyme Engineering			Enzyme Engineering
CE 7.1	Renewable Energy Resources			Renewable Energy Resources
CE 7.1	Computer Aided Process Plant Design			Computer Aided Process Plant Design

Course details: (See **Annexure II(A)**)

Semester: VIII

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
CE 8.1	Departmental Elective-I	4	0	0	4			Elective-I	4/3	0/1	0	4
CE 8.2	Departmental Elective-II	4	0	0	4			Elective-II	4/3	0/1	0	4
CE 8.3	Open Elective-I	4	0	0	4			Environmental Pollution Control	3	1	0	4
CE 8.4	Open Elective-II	4	0	0	4			Chemical Plant Simulation	3	1	0	4
CE 8.5	Process Plant Safety and Hazard Analysis	4	0	0	4			Process Plant Safety and Hazard Analysis	3	1	0	4
Total		**20**	**0**	**0**	**20**		**Total**		**17/16/15**	**3/4/5**	**0**	**20**

Existing			Proposed						
Departmental/ Open Elective			**Elective (Disciplinary)**						
#	**Course Name**		**#**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1.	Biochemical Engineering		1.	CHEG ????	Biochemical Engineering	3	1	0	4
2.	Chemical Plant Simulation		2.	CHEG ????	Petroleum Refining Technology	3	1	0	4
3.	Food Processing and Engineering		3.	CHEG ????	Polymer Science and Technology	3	1	0	4
4.	Nano-Science and Technology		4.	CHEG ????	Advanced Heat Transfer	3	1	0	4
5.	Petroleum Refining Technology		5.	CHEG ????	Advanced Chemical Reaction Engineering	3	1	0	4
6.	Polymer Science and Technology		6.	CHEG ????	Advanced Mass Transfer	3	1	0	4
			7.	CHEG ????	Optimization of Chemical Processes	3	1	0	4
			Elective (Open)						
			#	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
			1.	CHEG ????	Nano-Science and Technology	3	1	0	4
			2.	CHEG ????	Food Processing and Engineering	3	1	0	4
			3.	CHEM ????	Analytical Techniques	3	1	0	4
			4.	INST ????	Robotics and Automation	4	0	0	4
			5.	CS ????	Artificial Intelligence	4	0	0	4
			6.	CS ????	Cloud Computing	4	0	0	4

Course details: (See **Annexure II(A)**)

Name of the program: B. Tech. (Chemical Engineering)

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
1.	CHE 101 Thermodynamics	The students will be able to • Carryout thermodynamic analysis of real systems • Carryout thermodynamic analysis multiphase systems with chemical changes • Understand thermodynamic functions and their relationships	**Suggested Books:** 1. P. W. Atkins, Physical Chemistry, ELBS. 2. Puri, Sharma, Patania, Principles of Physical Chemistry, Vishal Publishing Co. 3. K.K. Sharma, L.K. Sharma, A Text Book of Physical Chemistry, Vikash Publishing House Pvt. Ltd. 4. P. K. Nag, Basic & Applied Thermodynamics, McHill Publication, Second Edition, 2009. 5. Hendrick C. Van Ness, Understanding Thermodynamics. 6. Gordon J. Van Wylen, Fundamentals of Classical Thermodynamics.	**Recommended Books:** 1. Atkins, P. W., & De, P. J. (2006). Atkins' Physical chemistry. Oxford: Oxford University Press. 2. Puri, S., Sharma, R. L. &Pathania M. S. (2004). Principles of Physical Chemistry. Vishal Publishing Co. 3. Sharma, K. K., & Sharma, L. K. (1977). A textbook of physical chemistry. Vikas Publishing House. 4. P. K. Nag (2009). Basic & Applied Thermodynamics.Tata McGraw Hill. 5. Van Ness, H. C. (1983). Understanding thermodynamics. Courier Corporation. 6. Van Wylen, G. J., & Sonntag, R. E. (1985). Fundamentals of classical thermodynamics. New York: Wiley. e-resource(s): https://nptel.ac.in	e-resource has been added
2.	ENGG 201 Structure and Properties of Materials	Students will be able to • Relate fundamentals of material properties with its utilization • Design and develop better products and equipment • Identify needs and applications of materials economically.	**Suggested Books:** 1. W. D. Callister, R. G. David "Materials Science and Engineering: An Introduction", 10th edition, Wiley, 2018. 2. J. F. Shackelford. Introduction to Material Science for Engineers. Eighth Edition, Pearson. 3. L. H. Van Vlack. Elements of Material science and Engineering. Sixth Edition. 4. B. Viswanathan, Structure and Properties of Solid State Materials. First Edition, Narosa Publications. 5. K. G. Budinski, M. K. Budinski.	**Recommended Books:** 1. Callister, W. D., &Rethwisch, D. G. (2018). Materials science and engineering: An introduction. 2. Shackelford, J. F. (2014). Introduction to materials science for engineers.Pearson. 3. Viswanathan B. (2006). Structure and Properties of Solid State Materials. Alpha Science Intl Ltd 4. Budinski, K. G., &Budinski, M. K. (2016). Engineering materials: Properties and selection. New Delhi: Pearson India Education. e-resource(s): https://nptel.ac.in	Elements of Materials Science and Engineering by L. H. Van Vlack is out of print, not suggested. e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
			Engineering Materials: Properties and Selection. Ninth Edition, Pearson.c		
3.	CHE 201 Chemical Engineering Thermodynamics	The students will be able to • Apply fundamental concepts of thermodynamics to engineering applications. • Estimate thermodynamic properties of substances in gas and liquid states. • Determine thermodynamic efficiency of various energy related processes. • Solve problems related to the solution thermodynamics.	**Text Book:** 1. Smith, J.M., Van Ness, H.C. and Abbott, M.M., "Introduction to Chemical Engineering Thermodynamics", 7th Ed., McGraw-Hill, 2005. **Reference Books:** 2. Rao, Y.V.C., "Chemical Engineering Thermodynamics", Universities Press (INDIA) Private Ltd. 1997 3. Koretsky, M.D., "Engineering and Chemical Thermodynamics", 2nd Ed., JohnWiley& Sons.	**Recommended Books:** 1. Smith, J. M., Van Ness, H. C., & Abbott, M. M. (2005). Introduction to Chemical Engineering Thermodynamics.New York: McGraw-Hill. 2. Rao, Y. V. C. (1997). Chemical engineering thermodynamics. Universities Press. 3. Koretsky, M. D. (2004). Engineering and chemical thermodynamics. New York: Wiley. e-resource(s): https://nptel.ac.in	e-resource has been added
4.	CHE 202 Chemical Process Calculations	The students will be able to • Make material balances on unit operations and processes • Perform simultaneous material and energy balances • Understanding the degrees of freedom analysis and its significance • Understande the concept of humidity and usage of psychrometric chart	**Text Book:** 1. Himmelblau, D. M and J. B. Riggs, "Basic Principles & Calculations in Chemical Engineering" 7th Edition, Pearson, 2009. **Reference Books:** 1. B.I. Bhatt and S.M. Vora "Stoichiometry" 4th ed., TATA McGraw-Hill Publishing Company, 2004. 2. O.A. Hougen, K.M. Watson, R.A. Ragatz; "Chemical Process Principles Part-I "-CBS Publication.	**Recommended Books:** 1. Himmelblau, D. M., & Riggs, J. B. (2009). Basic principles and Calculations in Chemical Engineering. Prentice Hall. 2. Bhatt, B. I. &Vora, S. M. (2004). Stoichiometry. New Delhi: Tata McGraw Hill. 3. Hougen, O. A., Watson, K. M. &Ragatz R.A. (2004). Chemical process principles Part I.CBS Publishers & Distributors Pvt. Ltd. e-resource(s): https://nptel.ac.in	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
5.	CHE 203 Fluid Mechanics	The students will be able to • Understand the basic principles of fluid mechanics • Analyze fluid flow problems with the application of the momentum and energy equations • Analyze pipe flows as well as fluid machinery	McCabe, W.L., Smith, J.C., and Harriott, P., "Unit Operations of Chemical Engineering", 7th ed., McGraw Hill, 2005.	**Recommended Books:** McCabe, W. L., Smith, J. C., &Harriott, P. (2005). Unit operations of chemical engineering. Boston: McGraw-Hill. e-resource(s): https://nptel.ac.in	e-resource has been added
6.	CHE 204 Heat Transfer	The students will be able to • Understand and solve conduction, convection and radiation problems • Design and analyze the performance of heat exchangers, condensers, boilers and evaporators • Design and analyze reactor heating and cooling system	**Text / Reference Books:** 1. Kern, D. Q., "Process heat transfer", Tata- McGraw Hill, 1950. 2. Holman, J. P., "Heat Transfer", 10th ed., McGraw Hill, New York, 2009. 3. Chapman, A. J., "Heat transfer", Maxwell Macmillan, 1984. 4. Dutta, B. K. "Heat transfer: Principles and Applications", PHI, New Delhi, 2001.	**Recommended Books:** 1. KERN, D. O. N. A. L. D. (2019). Process Heat Transfer. S.I.: Echo Point Books & Media. 2. Holeman, J. P., & Bhattacharyya, S. (2017). Heat transfer. Chennai: MsGraw Hill Education (India) Private Limited. 3. Chapman, A.J. (1984). Heat Transfer. Maxwell Macmillan. 4. Dutta, B. K. (2001). Heat transfer: Principles and Applications. New Delhi: PHI Learning Pvt. Ltd. e-resource(s): https://nptel.ac.in	e-resource has been added
7.	CHE 303 Chemical Reaction Engineering	The students will be able to • Analyze chemical reactors and reaction systems • Solve open-ended reaction engineering problems in teams • Calculate operating parameters for isothermal and non-isothermal operation of ideal well-mixed batch and continuous reactors, and for ideal plug-flow reactors • Formulate a set of consistent material and energy balance equations to describe operation of batch, semi-continuous and continuous reactor systems with	**Text Book:** • Levenspiel, O., "Chemical Reaction Engineering," 3rd ed., John Wiley & Sons, Singapore, 1999. **Reference Books:** 1. Scot Fogler, H., "Elements of Chemical Reaction Engg." 4th ed. Prentice-Hall of India, Delhi, 2007 2. Smith, J. M., "Chemical Engineering Kinetics," 3rd ed., McGraw-Hill, 1981.	**Recommended Books:** 1. Levenspiel, O. (1999). Chemical Reaction Engineering. Singapore: John Wiley & Sons. 2. Scott Fogler, H. (2015). Elements of Chemical Reaction Engineering. Delhi: Prentice Hall. 3. Smith, J. M. (1981). Chemical engineering kinetics. McGraw-Hill. e-resource(s): https://nptel.ac.in	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		single or multiple reactions, operating with and without heat exchange • Choose an appropriate reactor type and operating conditions to achieve a desired output such as reactant conversion, selectivity and yield			
8.	CHE 304 Advanced Chemical Reaction Engineering	The students will be able to • Understand mechanism of catalytic reactions and analysis of kinetic data • Understand yield and selectivity of reaction and diffusion in porous catalyst • Design catalytic reactors • Understand rector design for different type of reactions	**Text Book:** 1. Levenspiel, O., "Chemical Reaction Engineering," 3rd ed., John Wiley & Sons, Singapore, 1999. **Reference Books:** 1. Scot Fogler, H., "Elements of Chemical Reaction Engg.," 4rt ed., Prentice-Hall of India, Delhi, 2007. 2. Smith, J. M., "Chemical Engineering Kinetics," 3rd ed., McGraw-Hill, 1981.	**Recommended Books:** 1. Levenspiel, O. (1999). Chemical Reaction Engineering. Singapore: John Wiley & Sons. 2. Scott Fogler, H. (2015). Elements of Chemical Reaction Engineering. Delhi: Prentice Hall. 3. Smith, J. M. (1981). Chemical engineering kinetics. McGraw-Hill. e-resource(s): https://nptel.ac.in	e-resource has been added
9.	CHE 305 Chemical Technology	The students will be able to • Understand important process industry in Chemical Engineering • Understanding of basic operations involved • Identify important aspects of a process flow diagram	**Text Book:** 1. Rao M.G. and M. Sittig, "Dryden's Outlines of Chemical Technology", Affiliated East West Press, 1997. **Reference Books:** 1. Shreve N., "Chemical Process Industries" 5th Edn. McGraw Hill, New York, 1984. 2. Faith W.L., Keyes D.B. and Clark R.L., "Industrial Chemicals", 4th Ed., John Wiley.	**Recommended Books:** 1. Rao, M. G., &Sittig, M. (1997). Dryden's Outlines of Chemical Technology. East-West Press Private Ltd. 2. Austin, G. T. (1984). Shreve's chemical process industries. McGraw Hill. e-resource(s): https://nptel.ac.in	e-resource has been added
10.	CHE 306 Computational Methods in Engineering	The students will be able to • Solve complex single and multivariable industrial problems using various numerical techniques • Convert industrial problems in to	**Text Book :** 1. Gupta, S. K., "Numerical Methods for Engineers," New Age International Ltd., New Delhi, 1995.	**Recommended Books:** 1. Gupta, S. K. (1995). Numerical methods for engineers. New Delhi: New Age International Publishers Ltd. 2. Hanna, O.T. &Sandall,O.C. (1975).	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		mathematical problems	**Reference Books :** 1. Hanna, O.T. and Sandall,O.C., "Computational Methods in Chemical Engineering," Prentice-Hall, 1975. 2. Sastry, S.S. "Introductory Methods of Numberical Analysis : PHI 4th Edition	Computational Methods in Chemical Engineering. Prentice-Hall. 3. Sastry, S.S. (2012). Introductory Methods of Numberical Analysis.Prentice Hall India Learning Private Limited. e-resource(s): https://nptel.ac.in	
11.	CHE 307L Environmental and Fuel Lab	The students will be able to • Determine different parameters associated with fuel analysis • Evaluate pollutants quality • Do sample collection and analysis of data to assess the environmental impact			No changes have been proposed
12.	CHE 308 Environmental Pollution Control	The students will be able to • Understand direct and indirect impact on human health • Understand methods to reduce pollution • Do waste management and utilization	**Text Books:** 1. Peavy, H. S., Rowe, D. R., Tchobanoglous, G., "Environmental Engineering" ; McGraw Hill, 1995. 2. Modi, P. N., "Sewage Treatment and Disposal and Waste Water Engineering," Vol. II, Standard Book House, Delhi, 2001. **Reference Book:** 1. Metcalf & Eddy, Inc., "Wastewater Engineering: Treatment and Reuse", 4th ed., Tata McGraw Hill, New Delhi, 2003.	**Recommended Books:** 1. Peavy, H. S., Rowe, D. R. Tchobanoglous, G. (1995). Environmental Engineering. McGraw Hill. 2. Modi, P. N. (2001). Sewage Treatment & Disposal and Waste Water Engineering. Standard Book House, Delhi. 3. Tchobanoglous, G., Burton, F. L., Stensel, H. D., & Metcalf & Eddy. (2003). Wastewater engineering: Treatment and reuse. Boston: McGraw-Hill.	No changes have been proposed
13.	CHE 309 Mass Transfer	The students will be able to • Learn about the diffusional mass transfer • Understand the operations of cooling tower and dryer • Understand the mechanism of	**Text Book :** 1. Treybl, R.E., "Mass transfer operations", 3rd ed. McGraw Hill, New York, 1980. **Reference Books :** 1. King, C.J., "Separation Process",	**Recommended Books:** 1. Treybl, R.E. (1980). Mass transfer operations. New York: McGraw Hill. 2. King, C.J. (1971). Separation Process. New York: McGraw Hill. 3. Smith, B.D. (1963). Design of	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		crystallization and absorption • Understand important parameters and carryout complex calculations involved in a distillation column operation and design	McGraw Hill, NY. 2. Smith, B.D., "Design of Equilibrium Stage-Process", McGraw-Hill, NY. 3. McCabe, W.I., Smith J.C. and Harriot, P., "Unit operation of chemical Engineering" 7th ed. McGraw Hill, NY. 4. Coulson, J.M. and Richardson, J.f., "Chemical Engineering" Vol. I & II, 4th ed. Asion Book, Pvt Ltd., New Delhi.	Equilibrium Stage-Process. New York: McGraw Hill 4. McCabe, W. L., Smith, J. C., &Harriott, P. (2005). Unit operations of chemical engineering. Boston: McGraw-Hill. 5. Coulson, J.M. and Richardson, J.f. (1990). Chemical Engineering Pergamon. e-resource(s): https://nptel.ac.in	
14.	CHE 310 Optimization of Chemical Process	The students will be able to • Apply the knowledge of optimization to formulate the problems • Apply different methods of optimization and to suggest a technique for specific problem with a single variable • Apply different methods of optimization and to suggest a technique for specific problem with multivariable • Apply of simplex method for linear optimization problems • Understand how optimization can be used to solve the industrial problems of relevance to the chemical industry	**Text Book:** 1. Edgar, T.F., Himmelblau, D. M., Lasdon, L. S., "Optimization of Chemical Process", 2nd ed., McGraw-Hill, 2001. **Reference Book:** 2. Rao, S.S., "Optimisation Techniques", Wiley Eastern, New Delhi, 1985.	**Recommended books:** 1. Edgar, T. F., Himmelblau, D. M., &Lasdon, L. S. (2001). Optimization of chemical processes. McGraw-Hill,. 2. Rao, S. S. (1985). Optimization Theory and Applications. New Delhi: Wiley Eastern. e-resource(s): https://nptel.ac.in	e-resource has been added
15.	CHE 311 Plant Design and Economics	The students will be able to • Understand concepts of process design and project management • Synthesize feasible and optimum flow-sheet • Design of energy integration of process (or heat exchanger network in the process)	**Text Book:** 1. Seider, W.D., Seader, J.D. and Lewin, D.R., "Product & Process Design Principles", 2nd edition, Wiley Student Edition, Wiley India, Reprint 2012. **Reference Books:**	**Recommended books:** 1. Seider, W.D., Seader, J.D. &Lewin, D.R. (2012). Product & Process Design Principles. Wiley India. 2. Smith, R., & Smith, R. (1995). Chemical process design. New York: McGraw-Hill. 3. Coulson, J. M., Sinnott, R. K., & Richardson, J. F. (1989). Chemical	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		• Estimation of capital investment, total product costs, and profitability • Optimum design of equipments based on economics and process considerations	1. R. Smith, "Chemical Process Design", McGraw Hill, New York, 1995. 2. R.K.Sinnot, "An Introduction to Chemical Engineering Design", Pergamon Press, Oxford, 1989.	engineering. Volume 6: An introduction to chemical engineering design. Oxford: Pergamon. e-resource(s): https://nptel.ac.in	
16.	CHE 312 Chemical Process Control	The students will be able to • Learn about field instrumentation • Understand dynamic modeling and behavior of a system • Understand design of controllers	**Text Books:** 1. Coughanowr, D. R., "Process Systems Analysis and Control", 2nd ed. McGraw Hill, 1991. 2. Jain, R.K., "Mechanical& Industrial measurements", Khanna Publishers, New Delhi. 1999. **Reference Books:** 1. Stephanopoulos, G., "Chemical Process Control", PHI, 1984. 2. Luyben, W. L., "Process Modeling, Simulation and Control for Chemical Engineers," McGraw Hill, 1973.	**Recommended Books:** 1. Coughanowr, D. R. (1991) Process Systems Analysis and Control. McGraw Hill. 2. Jain, R.K. (1999). Mechanical& Industrial measurements. New Delhi: Khanna Publishers. 3. Stephanopoulos, G. (1984). Chemical Process Control: An Introduction to Theory and Practice.Pearson 4. Luyben, W. L. (1973) Process Modeling, Simulation and Control for Chemical Engineers. New York: McGraw Hill. e-resource(s): https://nptel.ac.in	e-resource has been added
17.	CHE 313L Process Simulation Lab – I	The students will be able to • Handle simulation software • Select and implement appropriate theoretical model • Solve the process flow diagram using simulation software			No changes have been proposed
18.	CHE 314L Process Simulation Lab – II	The students will be able to • Handle simulation software • Select and implement appropriate theoretical model • Solve the process flow diagram using simulation software			No changes have been proposed
19.	CHE 315S Seminar	The students will be able to • Improve communication skills			No changes have been proposed

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		• Improve presentation of an idea/thought • Learn about current trends in research, process design and other aspects which may be beyond the boundary of the curriculum			
20.	CHE 320 Mechanical Operation	The students will be able to • Understand the importance of size reduction and screening operations in mineral industries • Classify various crushing and grinding units on the basis of working principle • Select appropriate unit for a particular type of sepration	**Text Books :** 1. McCabe, W.L., Smith, J.C., and Harriott, P., "Unit Operations of Chemical Engineering". 7th ed., McGraw Hill, 2005. 2. Chemical Engineers Hand Book by R.H. Perry and C.H. Chilton. **Reference Books :** 1. Chemical Engineering Vol.-I : Coulson & Richardson, Pergamon Press, 1979. 2. Momentum transfer operation : S.K. Gupta, 1979	**Recommended Books:** 1. McCabe, W. L., Smith, J. C., &Harriott, P. (2005). Unit operations of chemical engineering. Boston: McGraw-Hill. 2. R. H. Perry, C. H. Chilton, S. D. Kirkpatrick. (1963). Chemical engineers' handbook. New York: McGraw-Hill. 3. Coulson, J.M. and Richardson, J.f. (1990). Chemical Engineering Pergamon 4. Gupta, S. (1979). Momentum transfer operations. New Delhi: Tata Mcgraw-Hill. e-resource(s): https://nptel.ac.in	e-resource has been added
21.	CHE 402 Chemical Plant Simulation	The students will be able to • Understand the stages involved in the development of a process model • Formulate a chemical engineering problem as a mathematical model from basic engineering principles • Identify the appropriate numerical solutions used in solving the models • Apply various simulation tools for solving the chemical engineering models developed	**Text Book:** 1. Russell, T. W. F. and Denn, M. M., "Introduction to Chemical Engineering Analysis", John Wiley, NY, 1972. **Reference Books :** 1. Babu, B.V. "Process Plant Simulation", Oxford University Press, 2008. 2. Biegler, L., Grossmann, I. E. and Westerberg, A. W., "Systematic Methods of Chemical Engineering and Process Design," Prentice Hall, 1997.	Recommended books: 1. Fisher, R. J., &Denn, M. M. (1976). *Introduction to Chemical Engineering Analysis*. John Wiley. 2. Babu B.V. (2008). *Process Plant Simulation*. Oxford University Press. 3. Biegler, L. T., Grossmann, I. E., & Westerberg, A. W. (1997). Systematic methods for chemical process design.	No changes have been proposed
22.	CHE 404R Corrosion Engineering	The students will be able to • Understand the electrochemical and metallurgical behavior of	**Text Book:** 1. Fontana and Greene., Corrosion Engineering, McGraw Hill Book	**Recommended Books:** 1. Fontana, M. G. (2005). Corrosion engineering. Tata McGraw-Hill Education.	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		corroding systems. • Apply the electrochemical and metallurgical aspects of combating eight forms of corrosion. • Select or choose the testing procedures for corroding systems. • Evaluate the polarization behavior of corroding systems. • Design of suitable materials, methods to combat corrosion. • Predict the function of corrosion inhibitor	Co, New York, 1983 **Reference Books :** 1. Raj Narayan ., An Introduction to Metallic Corrosion and its prevention, Oxford and IBH, New Delhi, 1983 2. Budinski, K.G., Surface Engineering for Wear Resistance, Prentice Hall Inc., Engelwood Cliff, New Jersey, USA, 1988. 3. Uhlig, H.H., Corrosion and Corrosion Control, John Wiley and Sons, New York, USA, 1985.	2. Narayan, R. (1983). An introduction to metallic corrosion and its prevention. Mohan Primlani for Oxford & IBH Publishing Company. 3. Budinski, K. G. (1988). Surface Engineering for Wear Resistance.(Retroactive Coverage). Prentice-Hall, Inc. 4. Uhlig, H.H. (1985). Corrosion and Corrosion Control. New York: John Wiley and Sons. e-resource(s): https://nptel.ac.in	
23.	CHE 407R Membrane Separation Technology	The students will be able to • Understand the principles and materials properties for different membrane separation processes • Identify the best membrane modules and manufacturing process for different applications • Identify and design the suitable membrane separation technique for intended problem	**Text Books:** 1. Mulder M., "Basic Principles of Membrane Technology", 2nd Edition, Kluwer Academic Publisher, 1996. 2. Baker, R.W., Membrane Technology and Applications, Wiley Interscience, Singapore, 2nd Edition, 2004. **Reference Books :** 1. Richard D. Noble "Member one sepoarations" Technology Principles and applications Elesivier. Firstedition 1995. 2. Strathmann, H., Ion, Exchange Membrane Separation Processes, Volume 9, Elsevier Science, New Delhi, 2004.	**Recommended Books:** 1. Mulder, M. (1996). Basic principles of membrane technology. Second. Kluwer Academic Pub. 2. Baker, R. W. (2012). Membrane technology and applications. John Wiley & Sons. 3. Noble, R. D., & Stern, S. A. (Eds.). (1995). Membrane separations technology: principles and applications (Vol. 2). Elsevier. 4. Strathmann, H. (2004). Ion-exchange membrane separation processes (Vol. 9). Elsevier. e-resource(s): https://nptel.ac.in	e-resource has been added
24.	CHE 408 Nano-Science and Technology	The students will be able to • Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology • Identify the principles of	**Text Books:** 1. Steed J. & Atwood J., "Supramolecular Chemistry", Johan Wiley & Sons, 2004. 2. C. Brechignac P. Houdy M.	Recommended books: 1. Steed, J. W., & Atwood, J. L. (2013). *Supramolecular chemistry*. John Wiley & Sons. 2. Bréchignac, C., Houdy, P., &Lahmani, M.	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		processing, manufacturing and characterization of nanomaterials and nanostructures • Apply the electronic microscopy, scanning probe microscopy and nano-indentation techniques to characterize the nano-materials and nanostructures • Evaluate and analyze the mechanical properties of bulk nanostructured metals and alloys, nano-composites and carbon nano-tubes	Lahmani, "Nanomaterials and Nanochemistry" EMRS, 2006 **Reference Books:** 1. Lehn, J. M. "Supramolecular Chemistry", Wiley VCH, 1995. 2. J. Dutta& H. Hofmann : NANOMATERIALS	(Eds.). (2008). *Nanomaterials and nanochemistry*. Springer Science & Business Media. 3. Lehn, J. M. (1995). *Supramolecular chemistry* (Vol. 1). Germany: Vch, Weinheim. e-resource(s): https://nptel.ac.in	
25.	CHE 409 Petroleum Refining Technology	The students will be able to • Introduction with the petroleum refinery worldwide • Develop knowledge of different refining processes • Develop knowledge of safety and pollution control in the refining industries. • To find the suitable refining technology for maximizing the gasoline yield	**Text Book:** 1. Prasad, R., "Petroleum Refining Technology," 4th ed., Khanna Publishers, Delhi, 2007. **Reference Book :** 1. Nelson, W. L., "Petroleum Refinery Engineering," 4th ed., McGraw Hill, 1987.	Recommended books: 1. Prasad, R. (2007). *Petroleum Refining Technology*. Khanna Publishers. 2. Nelson, W. L. (1985). *Petroleum refinery engineering*. Auckland: McGraw-Hill. e-resource(s): https://nptel.ac.in	e-resource has been added
26.	CHE 410 Polymer Science and Technology	The students will be able to • Comprehend basics of polymer science • Students would learn concept of average molar masses and molar mass distributions • Students would be introduced elastomers, plastics and fibers that are used in the industry • Students would learn fundamentals of Step-growth polymerization • Students would learn fundamentals of Chain/addition polymerization-ionic and free radical	**Text Book:** 1. V.R.Gowarikar, N.V. Viswanathan and JayadevSredhar, "Polrymer Science" IndraNatirdIst Edition. **Reference Books:** 1. Rodringuez, "Principles of Polymer Systems", Tata McGraw Hill, 1970. 2. Billmayer Jr. and Fred. W., "Textbook of Polymer Science", Wiley Tappers, 1965. 3. David, J. W., "Polymer Science and Engineering", Prentice Hall, 1971.	Recommended books: 1. Gowariker, V. R., Viswanathan, N. V., &Sreedhar, J. (1986). *Polymer science*. New Age International. 2. Rodriguez, (1970). *Principles of polymer science*. Tata McGraw Hill. 3. David, J. W. (1971). *Polymer Science and Engineering*, Prentice Hall e-resource(s): https://nptel.ac.in	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		polymerization			
27.	CHE 411 Process Plant Safety and Hazard Analysis	The students will be able to • Students will be provided the guidance to key techniques and methods used in industry for identifying and documenting safety and health hazards and their controls. • It also contains examples that explain how to identify hazards, analyze hazards and controls, document the results of an analysis, and manage residual risk	**Text Book:** 1. Crowl D.A. and Louvar J.A., Chemical process safety fundamentals with applications," 3rd edition Prentice Hall of India, New Delhi. **Reference Books :** 1. Wentz, C.A. "Safety health and enuironment protection" McGraw Hill I Van winkle, Distillation McGraw Hill. 2. Smith, B.D., "Design of equilibrium state process," McGraw Hill l. Van Winkle, "Distillation," McGraw Hill.	Recommended books: 1. Crowl, D. A., &Louvar, J. F. (2001). *Chemical process safety: fundamentals with applications*. Pearson Education. 2. Wentz, C. A. (1998). *Safety, health, and environmental protection*. McGraw-Hill Companies. 3.Smith, B. D. (1963). *Design of equilibrium stage processes*. McGraw-Hill Companies. e-resource(s): https://nptel.ac.in	e-resource has been added
28.	CHE 413P UIL Project	The students will be able to • Identify the gap between the needs of society and available technology through literature survey • Formulate the objectives of their study • Communicate objectives of their study • Aggregate research in the form of a written report			Credits of the course are aligned with other BTechprogrammes
29.	CHE ???R Enzyme Engineering	The students will be able to: • Recognize the factors affecting enzyme activity and its kinetics • Understand the role enzyme as a catalyst in chemical industries • Understand how enzyme kinetics affects reactor design for large scale production	**Text Book:** • Bailey, J. E, Ollis, D.F., Biochemical Engineering Fundamentals, McGraw Hill Publishing Company, New York, 2nd Edition, 1986 **Reference Books :** 1. Wiseman, Hand book of Enzyme Biotechnology, Ellis - Hardwood, Netherlands, 1983 2. Enzyme Handbook Volume 12	**Recommended Books:** 1. Bailey, J. E., &Ollis, D. F. (1986). Biochemical engineering fundamentals. New York: McGraw Hill Publishing Company. 2. Wiseman, A. (1985). Handbook of enzyme biotechnology. E. Horwood. 3. Schomburg, D., Stephan, D., &GesellschaftfuÌ rBiotechnologischeForschung (Braunschweig, Germany). (1996). Enzyme handbook: 12. Berlin: Springer.	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
			Class 2.3.2, 2.6 Transferases, Springer Loose Leaf, London, 1st Edition, 1996. 3. Pye, E.K, Wingard, L.B, Enzyme Engineering II, Plenum Press, 1974. 4. Palmer T., Enzymes (Biochemistory Biotechnology clinical chemistry). First Esttwast Press Edition 2004.	4. Pye, E. K, &Wingard, L. B. (1974). Enzyme engineering: 2. New York: Plenum Press. 5. Palmer, T., & Bonner, P. L. (2007). Enzymes: biochemistry, biotechnology, clinical chemistry. Elsevier. e-resource(s): https://nptel.ac.in	
30.	CHE ???R Renewable Energy Resources	The students will be able to: • Recognize the types of renewable energy resources • Recognize the advantages of renewable energy resources on environment • Do cost benefit analysis • Efficiency of renewable energy systems as compared to conventional energy system	**Text Book:** 1. G. D. Rai, "Non conventional energy sources", Khanna Publishers, New Delhi 2007. **Reference Books :** 1. Singhal R. K. "Non conventional energy sources" Katson publishers, New Delhi 2009. 2. M. Chiogioji, "Industrial Energy Conservation", McGraw Hill, New York, 1979. 3. Chetan Singh solanki, "Renewable energy technologies" PHI, New Delhi, 2009.	**Recommended Books:** 1. Rai, G. D. (2013). Non-conventional sources of energy. Khanna Publishers. 2. Singal, R. K. (2009). Non-Conventional Energy Resources. SK Kataria and Sons. 3. Chiogioji, M. H. (1979). Industrial energy conservation.New York: McGraw Hill. 4. Solanki, C. S. (2009). Renewable energy technologies: A practical guide for beginners. PHI Learning Pvt. Ltd. e-resource(s): https://nptel.ac.in	e-resource has been added
31.	CHE ???R Computer Aided Process Plant Design	The students will be able to: • Create hierarchy of process design • Develop models for preliminary systems • Create CAD model for fluid, heat and mass transfer equipment	**Text Books:** 1. Bhattacharyya, B.C, Narayanan, C.M., Computer aided design of Chemical Process Equipment, New Central Book Agency (P) LTD, New Delhi, 1st Edition , 1992 2. Robin Smith, Chemical Process Design, McGraw Hill Inc, New York, 1995 **Reference Books :** 1. Hussein, A., Chemical Process Simulation, Wiley, Singapore,	**Recommended Books:** 1. Bhattacharyya, B.C & Narayanan, C.M., (2012). Computer aided design of chemical process equipment. New Delhi: New Central Book Agency (P) LTD. 2. Smith, R., & Smith, R. (1995). Chemical process design. New York: McGraw-Hill. 3. Husain, A. (1986). Chemical process simulation. New Delhi: Wiley Eastern Limited. 4. Coker, A. K. (1995). Fortran Programs for Chemical Process Design, Analysis, and	No change

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
			1986 2. Coker, A.K., FORTRAN programme for chemical process design, analysis and Simulation, Gulf Publishing Co, 1995.	Simulation. Gulf Publishing Company.	
32.	CHE ???R Biochemical Engineering	The students will be able to: • Kinetics of enzymatic reactions • Understand about metabolic stoichiometry and energetic • Design and analysis of biological reactors • Do economic analysis bioprocess		e-resource(s): https://nptel.ac.in	e-resource has been added
33.	CHE ???R Food Processing and Engineering	The students will be able to: • Understand the importance of food processing • Identify process conditions for food processing • Carryout food processing at ambient temperature • Select suitable medium such as heat, air, oil etc. for food processing • Identify post processing operations for storage and distribution		e-resource(s): https://nptel.ac.in	e-resource has been added
34.	CHE ???? Advanced Mass Transfer	The students will be able to: • Understand concepts of distillation, liquid-liquid extraction, leaching and crystallization • Carryout calculations involved in design of distillation, liquid-liquid extraction, leaching and crystallization units using various methods used in industries		e-resource(s): https://nptel.ac.in	e-resource has been added
35.	Advanced Heat Transfer	The students will be able to: • Understand flowbehaviour in boundary layers		**Section-A** Introduction; molecular momentum transport; convective momentum transport; velocity	This course has been introduced as elective in BTech

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		• Do analogs study between heat, mass and momentum • Recognize factors affecting during transport of mass and energy • Do make energy balances in boundary layers		distribution in laminar flow; Equations of change for isothermal systems; Equations of change, applications of equations of change; velocity distribution with more than one independent variables, stream functions and velocity potential, flow near solid surfaces, molecular energy transport, convective energy transport. **Section-B** Energy balances; convection; equation of change for non-isothermal systems; applications of equations of change; temperature distribution with more than one independent variable; molecular mass transport; convective mass transport; mass balances; concentration distribution in solids and laminar flow. **Section-C** Concentration distribution with more than one independent variable: boundary layer theory, turbulent flow, velocity distribution in turbulent flow; temperature distribution in turbulent flow; concentration distribution in turbulent flow. **Text Book:** 1. Bird, R.B., Steward W.E..&LightfootE.N., "Transport Phenomena" 2nd Edition, John Wiley & Sons. 2000. **Reference Books:** 1. Deen, W.M., "Analysis of Transport Phenomena" Oxford University Press, New York, 1998. 2. Welty, J.R., Wicks, C.E., Wilson, R.E., &Rorrer, G., "Fundamentals of Momentum, Heat and MassTransfer" 4th Edition, John Wiley & Sons, New York.2001. e-resource(s): https://nptel.ac.in	VIII semester

Programme& Course Format for BOS Minutes

Name of the Programme: MTech (Chemical Engineering)

Programme Educational Objectives:

- To develop latitude of effectiveness in solving advanced/complex engineering problems and tasks using engineering, science and statistics principles.
- To develop longitude of not only opening careers in the branch of study as well as interdisciplinary and multidisciplinary fieldswith the help of compulsory and elective courses followed by one year of project work in Industry along with reading electives.
- To develop altitude of professionalism to function effectively in the complex modern work environment, both as individuals as well as in team, with the ability to assume leadership roles and achieve understanding and appreciation of ethical behavior, social responsibility and diversity.

Programme Outcomes: Each graduate will be able to

- Evaluate the impact of their work on society, including ethical, economic, global and environmental aspects and deliver effective presentations of engineering results in written and oral formats.
- Apply their life-long learning skills and engineering knowledge to critically evaluate relevant literature and new technologies or systems and become effective leaders, capable of working in diverse environments.

Programme Scheme:

Semester: I

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
CHE 505	Advanced Process Control	4	0	0	4			Advanced Process Control	4	0	0	4
CHE 506	Advanced Reaction Engineering	4	0	0	4		CHE 304	Advanced Chemical Reaction Engineering	3	1	0	4
CHE 517	Equipment Design	4	0	0	4			Equipment Design	4	0	0	4
CHE 501L	Advanced chemical Engineering Lab	0	0	12	6			Advanced chemical Engineering Lab	0	0	12	6
	Elective -I	4	0	0	4			Elective -I	4	0	0	4
	Elective -II	4	0	0	4			Elective -II	4	0	0	4
	Total	**20**	**0**	**12**	**26**			**Total**	**19**	**1**	**12**	**26**

Course details: See Annexure-II(B)

Existing								Proposed							
Elective-I								**Elective-I**							
#	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**		**#**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CHE 512	Conceptual Design of Chemical Processes	4	0	0	4		1		Conceptual Design of Chemical Processes	4	0	0	4
2	CHE 513	Corrosion Science and Technology	4	0	0	4		2		Corrosion Science and Technology	4	0	0	4
3	CHE 524	Polymer Processing and Reaction Engineering	4	0	0	4		3		Polymer Processing and Reaction Engineering	4	0	0	4
4	CHE 527	Supercritical Fluid Extraction	4	0	0	4		4		Supercritical Fluid Extraction	4	0	0	4
Elective-II								**Elective-II**							
1	CHE 509	Bioenergy Engineering	4	0	0	4		1		Bioenergy Engineering	4	0	0	4
2	CHE 510	Catalysis and Surface Chemistry	4	0	0	4		2		Catalysis and Surface Chemistry	4	0	0	4
3	CHE 514	Cryogenic Engineering	4	0	0	4		3		Cryogenic Engineering	4	0	0	4
4	CHE 519	Industrial Heat Treatment	4	0	0	4		4		Industrial Heat Treatment	4	0	0	4

Semester:II

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
CHE 511	Computational Fluid Dynamics	4	0	0	4			Computational Fluid Dynamics	4	0	0	4
CHE 515	Energy Conservation	4	0	0	4			Energy Conservation	4	0	0	4
CHE 507L	Advanced Simulation Lab	0	0	12	6			Advanced Simulation Lab	0	0	12	6
	Elective -III	4	0	0	4			Elective -III	4/3	0/1	0	4
	Elective -IV	4	0	0	4			Elective -IV	4/3	0/1	0	4
	Elective -V	4	0	0	4			Elective -V	4	0	0	4
	Total	**20**	**0**	**12**	**26**			**Total**	**20/19/18**	**0/1/2**	**12**	**26**

Course details: See Annexure-II(B)

Existing								Proposed							
Elective-III								**Elective-III**							
#	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**		**#**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CHE 408	Nano-Science and Technology	3	1	0	4		1		Nano-Science and Technology	3	1	0	4
2	CHE 502	Advanced Chemical Engineering Thermodynamics	4	0	0	4		2		Advanced Chemical Engineering Thermodynamics	4	0	0	4
3	CHE 503	Advanced Heat Transfer	4	0	0	4		3		Advanced Heat Transfer	4	0	0	4
4	CHE 516	Environmental Safety and Impact Assessment	4	0	0	4		4		Environmental Safety and Impact Assessment	4	0	0	4
Elective-IV								**Elective-IV**							
1	CHE 306	Computational Methods in Engineering	3	1	0	4		1		Computational Methods in Engineering	3	1	0	4
2	CHE 317	Advanced Mass Transfer	3	1	0	4		2		Advanced Mass Transfer	3	1	0	4
3	CHE 523	Pinch Technology	4	0	0	4		3		Pinch Technology	4	0	0	4
4	CHE 525	Process and Product Development	4	0	0	4		4		Process and Product Development	4	0	0	4
Elective-V								**Elective-V**							
1	CHE 508	Advanced Transport Phenomena	4	0	0	4		1		Advanced Transport Phenomena	4	0	0	4
2	CHE 518	Fluidization Technology	4	0	0	4		2		Fluidization Technology	4	0	0	4
3	CHE 521	Natural and Synthetic Polymers	4	0	0	4		3		Natural and Synthetic Polymers	4	0	0	4

4	CHE 526	Processing of Alternative Fuels	4	0	0	4		4		Processing of Alternative Fuels	4	0	0	4

Semester:III

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective-I	0	0	4	2			Reading Elective-I	0	0	4	2
CHE 604P	Project (Part-I)	0	0	48	24			Project (Part-I)	0	0	48	24
Total		**0**	**0**	**52**	**26**		**Total**		**0**	**0**	**52**	**26**

Course details: See Annexure-II(B)

Existing								Proposed							
Reading Elective-I								**Reading Elective-I**							
#	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**		**#**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CHE 601R	Green Energy	0	0	4	2		1		Green Energy	0	0	4	2
2	CHE 602R	ISO Practices in Industries	0	0	4	2		2		ISO Practices in Industries	0	0	4	2
3	CHE 603R	Life Cycle Assessment	0	0	4	2		3		Life Cycle Assessment	0	0	4	2

Semester:IV

Existing							Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**		**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective-II	0	0	4	2			Reading Elective-I	0	0	4	2
CHE 605P	Project (Part-II)	0	0	48	24			Project (Part-II)	0	0	48	24
	Total	**0**	**0**	**52**	**26**			**Total**	**0**	**0**	**52**	**26**

Course details: See Annexure-II(B)

Existing								Proposed							
Reading Elective-I								**Reading Elective-I**							
#	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**		**#**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CHE 606R	Safety in Process Industry	0	0	4	2		1		Safety in Process Industry	0	0	4	2
2	CHE 607R	Social Responsibilities of Industries	0	0	4	2		2		Social Responsibilities of Industries	0	0	4	2
3	CHE 608R	Water and Land Pollution	0	0	4	2		3		Water and Land Pollution	0	0	4	2

Name of the program: MTech. (Chemical Engineering)

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
1.	CHE 506 Advanced Reaction Engineering	The students will be able to: • Understand mechanism of catalytic reactions and analysis of kinetic data. • Understand yield and selectivity of reaction and diffusion in porous catalyst. • Design catalytic reactors. • Understand rector design for different type of reactions. .	CHE 506 Advanced Reaction Engineering (**ARE**) **Section-A** **Heterogeneous Catalysis and Catalytic Processes:**Characterization of catalysts: engineering properties of catalysts, BET surface area, pore volume, pore size, pore size distribution, N2 adsorption method, mercury helium method, BET isotherm, Physical and Chemical Adsorption, Steps in catalytic reaction**Mechanism of catalytic reactions:**Langmuir-Hinshelwood and Eley-Rideal Mechanism, Determination of rate expressions using adsorption, surface reaction and desorption as rate controlling step, Determination of rate of reaction from experimental data, Preparation of catalysts. **Section-B** **Catalyst Deactivation:**Types of Catalyst Deactivation, Catalyst deactivation kinetics **Global and intrinsic rates:**Effect of Diffusion on Reaction Rate, Development of rate equations for solid catalyzed fluid phase reactions, Effective diffusivity, Thiele Modulus, isothermal and non-isothermal effectiveness factor, Estimation of kinetic parameters: Experimental determination of effectiveness factor weize-prater criteria, Determination of Global Rate of Reaction, Heterogeneous laboratory reactors. **Section-C** Gas-Liquid Reactions on solid catalyst and Packed bed catalytic reactors:trickle bed, slurry	CHE 304 Advanced Chemical Reaction Engineering(**ACRE**) **Section-A** **Catalysts:** Description methods of preparation and manufacture; catalyst characterization BET surface area, pore volume pore size distribution. Catalyst Reaction Kinetic Models: Physical and chemical adsorption; Determination of rate expressions using adsorption, surface reaction and desorption as rate-controlling steps. **Determination of Global Rate of Reaction :** Heterogeneous laboratory reactors; Determination of rate expressions from experimental data. Effect of Intrapellet Diffusion on Reaction Rates in Isothermal Pellets: concept of effectiveness factor, Thiele modulus, experimental determination of effectiveness factor-Weisz- Prater criteria, Non-isothermal effectiveness factor. **Section-B** **Packed bed catalytic reactors:** suspended solid reactors, bubbling fluidized bed and circulating fluidized bed reactors. **Deactivating Catalyst:** mechanism of deactivation, rate & performance equations. **Gas-Liquid Reactions on solid catalyst:** trickle bed, slurry reactors, three-	The course **ARE** can be replaced with the course **ACRE**as major portion of the syllabus is common. Common portion of the syllabus is highlighted. The common portion has been shown by grey color.

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
			reactors, three-phase fluidized beds, general rate equations & performance equations, Design of fixed bed catalytic reactor: isothermal, adiabatic, non-isothermal reactors: one dimensional, two dimensional approaches. **Text / Reference Books:** 1. Levenspiel, O., "Chemical Reaction Engineering," 3rd ed., John Wiley & Sons, Singapore, 1999. 2. Fogler, H. S., "Elements of Chemical Reaction Engineering," 3rd ed., Prentice-Hall of India, Delhi, 2003. 3. Froment, G.F., Bischoff, K.B., "Chemical Reactor Analysis and Design," 2nd ed, John-Wiley, New York, 1990. 4. Smith, J. M., "Chemical Engineering Kinetics", 2nd Ed., McGraw-Hill, 1981	phase fluidized beds, general rate equations & performance equations. **Section-C** **Non-catalytic systems**: rate equations for fluid-fluid reactions, reactor design; **Fluid particle reaction kinetics**:selection of a model, shrinking core model for spherical particle of unchanging size, rate equation and determination of the rate controlling step. Fluid–particle reactors design. **Recommended books:** 1. Levenspiel, O. (1999). Chemical reaction engineering. John Wiley & Sons. 2. Fogler, H. S. (2010). *Elements of Chemical Reaction Enggi*. Pearson Education. 3. Smith, J. M. (1981). *Chemical engineering kinetics*. McGraw-Hill. e-resource(s): https://nptel.ac.in	
2.	CHE 502 Advanced Chemical Engineering Thermodynamics	Students will be able to • Understand the importance and relevance of thermodynamics in life processes • Analyze various situations and apply the concepts of thermodynamics to problem solving. • Work with single and multiphase systems of pure materials and mixtures.	**Text bookÿ** 1. A. Bejan, Advanced Engineering Thermodynamics, 3rd edition, John Wiley and sons, 2006. 2. Stanley I. Sandler, Chemical and Engineering Thermodynamics, Wiley Series in Chemical Engineering , 2002. **Reference bookÿ** 1. J. M. Prausnitz, R. N. Lichenthaler and E. G. Azevedo, Molecular Thermodynamics	Recommended Books: 1. Bejan, A. (2016). *Advanced engineering thermodynamics*. John Wiley & Sons. 2. Sandler, S. I. (2017). *Chemical, biochemical, and engineering thermodynamics*. John Wiley & Sons. 3. Sandler, S. I. (2017). *Chemical, biochemical, and engineering*	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		• Apply the knowledge of thermodynamics to design problems.	of Fluid-Phase Equilibria, Prentice-Hall Inc., Englewood Cliff, 1986. 2. K. E. Smith and H. C. Van Ness, Introduction to Chemical Engineering Thermodynamics, 3rd ed. New York: McGraw-Hill Book Company, 1975. 3. H. C. Van Ness and M. M. Abbott, Classical thermodynamics of Non-electrolyte solutions, New York: McGraw-Hill Book Company, 1982.	*thermodynamics*. John Wiley &Sons. 4. Prausnitz, J. M., Lichtenthaler, R. N., & de Azevedo, E. G. (1998). *Molecular thermodynamics of fluid-phase equilibria*. Pearson Education. 5. Smith, J. M. &VanNess, A. (1975). *Introduction to chemical engineering thermodynamics*. Mc-Graw Hill. 6. Van Ness, H. C. (2015). *Classical thermodynamics of non-electrolyte solutions*. Elsevier. e-resource(s): https://nptel.ac.in	
3.	CHE 505 Advanced Process Control	Students will be able to: • Understand the basic principles & importance of process control in industrial process plants. • Specify the required instrumentation and final elements to ensure that well-tuned control is achieved. • Understand the use of block diagrams & the mathematical basis for the design of control systems. • Design and tune process (PID) controllers. • Use appropriate software tools for the modeling of plant dynamics and the design of well tuned control loops.	**Text Books:** 1. Stephanopoulos, G., *Chemical Process Control-An Introduction to Theory and Practice*, PHI learning Private Limited, New Delhi, 2010. 2. Luyben, W. L., *Process Modeling, Simulation and Control for Chemical Engineers*, McGraw Hill, 1973. **Reference Book :** 1. Coughanowr, D. R., *Process System Analysis & Control*, **2**nd Ed., McGraw Hill, 1991.	Recommended Books: 1.Stephanopoulos G. (2010). *Chemical Process Control: An Introduction to Theory and Practice*. New Delhi: PHI learning Private Limited. 2.Luyben, W. L. (1973). *Process Modeling, Simulation and Control for Chemical Engineers.* McGraw Hill. Coughanowr D. R. (1991). Process System Analysis & Control. McGraw Hill. e-resource(s): https://nptel.ac.in	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		• Understand the importance and application of good instrumentation for the efficient design of process control loops for process engineering plants. • Understand the experimental implementation of advanced process control schemes and the methods for process monitoring and diagnosis.			
4.	CHE507 Advanced Simulation Lab	Students will be able to: • Develop and implement dynamic models in simulation softwares • Investigate effect of operating parameters using simulator • Develop complex network of process flow diagram			No changes have been proposed
5.	CHE 509 Bioenergy Engineering	Students will be able to: • To judge the different options available given the nature of the feedstock. • To apply the acquired knowledge to design biomass energy plants and to evaluate their performances.	**Text Book :** 1. Bioenergy and Biofuel from Biowastes and Biomass edited by Samir Kumar Khanal; Samir K. Khanal , Rao Y. Surampalli , Tian C. Zhang , Buddhi P. Lamsal , R. D. Tyagi ,C. M. Kao ASCE publication. **Reference Book :** 1. "Synthetic Fuel Handbook: Properties, Process and Performance" by James. G. Speight; Mc- Graw Hill Publishers. 2. "Solid Waste Engineering"by P. AarneVesilind, William A. Worrell, Debra R. Reinhart.; Cengage Learning India Private Limited. 3. "Biomass and Renewable Energy Fuels and Chemicals" by Donald L. Klass;	Recommended Books: 1. Khanal S. K. & Rao Y. S. Zhang T. C. &Lamsal B. P. & Tyagi R. D. & Kao C. M. (1998). *Bioenergy and Biofuel from Biowastes and Biomass*. ASCE publication. 2. Vesilind P. A. & Worrell W. A. & Reinhart D. R. & Speight J. G. (1986). *Synthetic Fuel Handbook: Properties, Process and Performance.*Mc-Graw Hill Publishers. 3. *Solid Waste Engineering.*Cengage Learning India Private Limited. 4. Klass D. L. (1998) *Biomass and Renewable Energy Fuels and Chemicals*. Academic Press. 5. Sunggyu Lee S. & Shah Y. T. (2007). *Biofuels and Bioenergy: Processes and*	No changes have been proposed

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
			Academic Press (An Imprint of Elsevier). 4. "Biofuels and Bioenergy: Processes and Technologies" By Sunggyu Lee, Y.T. Shah; CRC Press.	*Technologies.* CRC Press.	
6.	CHE 511Computational Fluid Dynamics	Students will be able to: • Develop geometrical model of the flow • Toselectappropriate boundary conditions • Obtain solution of dynamic flows using different mathematical models	**Text Books:** H. K. Versteeg and W. Malalasekera, "An introduction to computational fluid dynamics", the finite volume method, Longman scientific & technical publishers, 2nd Ed. 2007. **Reference Books:** Vivek V. Ranade, Computational flow modeling for chemical reactor engineering Academic Press, San Diego, 2002.	Recommended Books: 1. Versteeg H. K. &Malalasekera W. (2007). *An introduction to computational fluid dynamics: the finite volume method.* Longman scientific & technical publishers. 2. Ranade V. V. (2002). *Computational flow modeling for chemical reactor engineering.* San Diego: Academic Press. e-resource(s): https://nptel.ac.in	e-resource has been added
7.	CHE 512 Conceptual Design of Chemical Processes	Students will be able to: • Identify the mathematical constraints involved in process design. • Identify other constraints such as local government policy, environment clearance, safety concern and economics which can change feasibility of a process. • Carryout flow sheeting of the process	**Reference books:** **R1.** Max S. Peters and Klaus D. Timmerhaus, "Plant Design and Economics for chemical Engineering", 4th edition, McGraw Hill, 1989. **R2.** R. Smith, "Chemical Process Design", McGraw Hill, New York, 1995. **R3.** R. K. Sinnot, "An Introduction to Chemical Engineering Design" *Pergamon Press*, Oxford, 1989.	Recommended Books: 1. Seider W. D. &Seader J. D. &Lewin D. R. (2012). *Product & Process Design Principles*. India: Wiley. 2. Peters M. S. &Timmerhaus K. D. (1989). *Plant Design and Economics for chemical Engineering*. McGraw Hill. 3. Smith R. (1989). *Chemical Process Design*. New York: McGraw Hill. 4. Sinnot R. K. (1989). *An Introduction to Chemical Engineering Design*. Oxford: Pergamon Press. e-resource(s): https://nptel.ac.in	e-resource has been added
8.	CHE 514 Cryogenic Engineering	Students will be able to: • Understand utilization of	**Text book(s)** 1. Randall Baron, Cryogenic System,	Recommended Books: 1. Baron R. (2003). Cryogenic System.	No changes have been proposed

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		cryogenic engineering in the benefit of the society • Understand working principles of various units such as cryo-coolers, gas-liquefaction unit, refrigeration etc.	McGraw Hill 2. K.D. Timmerhaus& T.M. Flynn, Cryogenic Process Engineering, Plenum Press. **Reference Books :** 1. Russel B Scott, Cryogenic Engineering, Van Nostrand 2. R W Yance and WM Duke, Applied Cryogenic Engineering, John Willey.	New York: McGraw Hill 2. Timmerhaus K. D. & Flynn T. M. (2004). *Cryogenic Process Engineering*. Plenum Press. 3. Russel B. S. (2003). *Cryogenic Engineering* Van Nostrand. 4. Yance R W & Duke W. M. (2009). *Applied Cryogenic Engineering*. John Willey.	
9.	CHE 515 Energy Conservation	Students will be able to: • Carryout energy auditing, waste heat recovery and renewable energy resources. • Carryout calculations related to pay-back, energy management, performs, energy conservation opportunities in various equipments, controllers and heat pumps. • Understand concepts of non-conventional energy sources, designs and calculation will be explained.	**Text/ Reference books:** 1. Frank Kreith, D. Yogi Goswami, "Energy management and conservation handbook", CRC Press. 2. Wayne C. Turner, Steve Doty, "Energy Management Handbook", The Fairmont Press, Inc. 3. G.D. Rai, "Non-conventional Energy Sources", Khanna Publishers. **Reference books:** 1. Craig B. Smith, "Energy Management Principles: Applications, Benefits, Savings", Pergamon. 2. Chakrabarti A., "Energy Engineering And Management", Phi Learning Private Limited.	Recommended Books: 1. Kreith F. &Goswami D. Y. (2003). *Energy management and conservation handbook.* CRC Press. 2. Turner W. C. & Doty S. (2005) *Energy Management Handbook*. The Fairmont Press Inc. 3. Rai G.D. (1997). *Non-conventional Energy Sources*. Khanna Publishers. 4. Smith Craig B. (2006). *Energy Management Principles: Applications, Benefits, Savings*. Pergamon. 5. Chakrabarti A. (2015). *Energy Engineering And Management.* Phi Learning Private Limited. e-resource(s): https://nptel.ac.in	e-resource has been added
10.	CHE 517 Equipment Design	Students will be able to: • Identify design parameters • To design internal pressure vessels and external pressure vessels • To design special vessels (e.g. tall vessels) and various parts of	**Text Books:** 1. M. V. Joshi & V. V. Mahajani; "Process Equipment Design", Third Ed; Macmillan India Ltd. 2. R. K. Sinnot, "Chemical Engineering Design", Fourth Ed., Elsevier.	Recommended Books: 1. Joshi M. V. &Mahajani V. V. (1999) *Process Equipment Design*. Delhi: Macmillan India Ltd. 2. Sinnot R. K. (1998). *Chemical Engineering Design.* Elsevier. 3. Treybal R. E. (1995). *Mass-Transfer*	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		vessels (e.g. heads)	3. Robert E. Treybal, "Mass-Transfer Operations", Third Ed, McGraw Hill Education. **Reference Books:** 1. B. C. Bhattacharya, "Introduction to Chemical Equipment Design: Mechanical Aspects", First Ed, CBS Publishers and Distributors Pvt Ltd. 2. Crowl D. A. and Louvar J. A., "Chemical process safety fundamentals with applications", Third Ed, Prentice Hall of India, New Delhi.	*Operations*. McGraw Hill Education. 4. Bhattacharya B. C. (2001). *Introduction to Chemical Equipment Design: Mechanical Aspects.* Delhi: CBS Publishers and Distributors Pvt Ltd. 5. Crowl D. A. &Louvar J. A. (1995). *Chemical process safety fundamentals with applications*. New Delhi: Prentice Hall of India. e-resource(s): https://nptel.ac.in	
11.	CHE 518 Fluidization Technology	Students will be able to: • Understand the fluidization phenomena and operational regimes. • Design various types of gas distributors for fluidized beds and determine effectiveness of gas mixing at the bottom region. • Analyze fluidized bed behavior with respect to the gas velocity. • Develop and solve mathematical models of the fluidized bed.	**Text Book:** 1. D. Kunii and O. Levenspiel, Fluidization Engineering, Butterworth, 1991. **Reference Books:** 1. D. Gidaspow, Multiphase Flow and Fluidization: Continuum and Kinetic Theory Description, Elsevier Science & Technology, 1993. 2. L.G. Gibilaro, Fluidization dynamics, Butterworth Heinemann, 2001.	Recommended Books: 1. Kunii D. &Levenspiel O. (1991). *Fluidization Engineering*. Butterworth. 2. Gidaspow D. (1993). *Multiphase Flow and Fluidization: Continuum and Kinetic Theory Description*. Elsevier Science & Technology. 3. Gibilaro L.G. (2001). *Fluidization dynamics.* Butterworth Heinemann. e-resource(s): https://nptel.ac.in	e-resource has been added
12.	CHE 519 Industrial Heat Treatment	Students will be able to: • Understand details analysis of heating process, heating or cooling requirements and problems encountered during heat treatment • Learn about how control material properties with-out using stress • Identify solution using	**Text/Reference Books:** 1. G. E. Dieter, "Engineering Design: A Materials and Processing Approach", McGraw hill, 3rd edition. 2. Y. Lakhtin and N. Weinstein, "Engineering physical metallurgy and heat treatment", 3. S. H. Avner, "Introduction to physical metallurgy", TATA McGraw hill, 2Nd	Recommended Books: 1. Dieter, G. E. (1999). *Engineering Design: A Materials and Processing Approach.* New York: McGraw hill. 2. Lakhtin Y. & Weinstein N. (1980). *Engineering physical metallurgy and heat treatment*. Central Books Ltd. 3. Avner S. H. (2016). *Introduction to physical metallurgy.* Delhi: TATA McGraw hill.	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		automation for time-temperature controlled treatment to change material properties	edition. 4. J. B. Bralla, "Design for manufacturability handbook", McGraw hill handbooks, 2nd edition.	4. Bralla J. B. (1998). *Design for manufacturability handbook.* New York: McGraw hill handbooks. e-resource(s): https://nptel.ac.in	
13.	14. CHE 523 Pinch Technology 15.	The students will be able to: • Explain the role of thermodynamics in process design • Calculate the minimum heating and cooling requirements for a process • Identify existing non-optimal arrangements of heat exchangers • Calculate lower cost solutions for arrangements of heat exchangers • Critically assess any design changes to process.	**Text Books** 1. V. UdaySheno, Heat Exchanger network synthesis, Gulf Publishing Co, USA, 1995 2. James M. Douglas Conceptual Design of Chemical Process, McGraw Hill, New York, 1988. **Reference Books:** 1. Linnhoff, B. Townsend D.W., Boland D., Hewitt G.F., Thomas, B.E.A., Guy, A.R. and Marsland, R.H., "A User's guide on process integration for the efficient use of energy", Inst. Of Chemical Engineers, London (1982). 2. Smith, R., "Chemical Process Design", McGraw Hill (1995).	Recommended Books: 1. Shenoy, U. V. (1995). *Heat exchanger network synthesis: process optimization by energy and resource analysis*. Gulf Professional Publishing. 2. Douglas, J. M. (1988). *Conceptual design of chemical processes* (Vol. 1110). New York: McGraw-Hill. 3. Linnhoff, B. (1982). User guide on process integration for the efficient use of energy. *AIChE J.*, *28*, 000-000. 4. Smith, R., & Smith, R. (1995). *Chemical process design* (pp. 8-13). New York: McGraw-Hill.	No changes have been proposed
16.	17. CHE 525 Process and Product Development 18.	The students will be able to: • To understand the basic concepts of process design, process development and product development. • To apply material and energy balances for process development using process data. • To apply algorithms for feasibility and optimization offlow sheet. • To apply the scaling up processes.	**Text Books:** 1. Process Development - From the Initial Ideal to the Chemical Production Plant G H Vogel, Wiley- VCH Verlag GmbH, 2005. 2. Conceptual Design of Chemical Process, J M Douglas, McGrawHill Book Company. 1998. **Reference Books:** 1. Chemical Process Development, Jordan, Mc-Graw Hill. 2. Product and Process Design Principles- Synthesis, Analysis and Evaluation, 2nd	Recommended Books: 1. Vogel, G. H. (2005). *Process development: from the initial idea to the chemical production plant*. John Wiley & Sons. 2. Perkins, J. D. (1989). Conceptual design of chemical processes JM Douglas, McGraw-Hill, New York, 1988. pp. xviii+ 601, price£ 32.50. ISBN 0-07-017762-7. *Journal of Chemical Technology & Biotechnology*, *46*(3), 249-249 3. Jordan, D. G. (1968). Chemical	No changes have been proposed

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
			ed., W D Seider, J D Seader and D R Lewin, John Wiley and Sons. 2004. 3. Analysis, Synthesi and Design of Chemical Processes, R Turton, R C Bailie, W B Whiting, J A Shaeiwitz, Prentice Hall, New Jursey. 1998	process development. 4. Seader, J. D., Seider, W. D., &Lewin, D. R. (2004). *Product and process design principles: synthesis, analysis and evaluation*. Wiley. 5. Turton, R., Bailie, R. C., Whiting, W. B., &Shaeiwitz, J. A. (2008). *Analysis, synthesis and design of chemical processes*. Pearson Education.	
19.	CHE 601R Green Energy	The students will be able to: • Identify the need of wind Energy and solar energy and the various components used in energy, generation and know the classifications. • Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications. • Compare Solar, Wind and bio energy systems, their prospects, advantages and limitations.	**Text Books:** 1. J. Twidell and T. Weir,"Renewable Energy Resources", Wiley, New York, 2nd Ed, 2006. **Reference Books:** 1. S. E., Manahan,"Green Science and Technology", CRC Press, 2nd Ed, 2006. 2. A.Demirbas, "Green Energy and Technology" Springer-Verlag London Limited, Ed.2009 3. S.P. Sukhatme,"Solar Energy - Principles of thermal collection and storage", Tata McGraw Hill. 4. T. Burton, D. Sharpe, N. Jenkins, E.Bossanyi,"Wind Energy Handbook" Wiley.	Recommended Books: 1. Twidell, J., & Weir, T. (2006). *Renewable energy resources*. Routledge 2. Manahan, S. E. (2006). *Environmental science and technology: a sustainable approach to green science and technology*. CRC Press. 3. Demirbaş, A. (2009). Green energy and technology biofuels. 4. SP Sukhatme. Solar Energy — Principles of Thermal Collection and Storage,Tata McGraw-Hill, 5. Sharpe, D., Burton, T., Jenkins, N., &Bossanyi, E. (2013). *Wind energy handbook*. Wiley. e-resource(s): https://nptel.ac.in	e-resource has been added
20.	CHE 604P Project (Part – I)	The students will be able to • Identify the gap between the needs of society and available technology through literature survey			No changes have been proposed

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
		• Formulate the objectives of their study • Communicate objectives of their study Aggregate research in the form of a written report			
21.	CHE 605P Project (Part – II)	The students will be able to • Identify the gap between the needs of society and available technology through literature survey • Formulate the objectives of their study • Communicate objectives of their study Aggregate research in the form of a written report			No changes have been proposed
22.	CHE 606R Safety in Process Industry	The students will be able to: • Potential hazards and hazardous conditions in process industries • Pay more attention on precaution to avoid accidents • Make carful decisions during plant malfunction	**Text Books:** 1. Mannan S.; "Lees' Loss Prevention in the Process Industries: Vol 1-2: Hazard Identification, Assessment and Control", 4th Ed., Butterworth-Heinemann Ltd. 2. Crowl D. A. and Louvar J. A., "Chemical Process Safety Fundamentals with Applications", 3rd Ed., Prentice Hall of India. **Reference books:** 1. Wentz, C.A., "Safety Health and Environmental Protection, McGraw Hill. 2. Sanders R. E., "Chemical Process Safety Learning from Case Histories", 3rd Ed., Butterworth–Heinemann.	Recommended Books: 1. Lees, F. (2012). *Lees' Loss prevention in the process industries: Hazard identification, assessment and control*. Butterworth-Heinemann. 2. Crowl, D. A., &Louvar, J. F. (2001). *Chemical process safety: fundamentals with applications*. Pearson Education. 3. Wentz, C. A. (1998). *Safety, health, and environmental protection*. McGraw-Hill Companies. 4. Sanders, R. E. (2015). *Chemical process safety: learning from case histories*. Butterworth-Heinemann. e-resource(s):	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
				https://nptel.ac.in	
23.	CHE 608R Water &Land Pollution	The students will be able to: • Predict impact of pollution on future and can take appropriate action for prevention • Identify causes of water and land pollution • Recognize the conventional techniques which can help in reducing pollution	**Text Book:** 1. W. W. Nazaroff and Lisa A.-C. John, "*Environmental Engineering Science",* Wiley & Sons, 2001. **References Book:** 1. M. Eisendbud, "Environmental radioactivity", Academic press. 2. T. Arnikar, "Essentials of nuclear chemistry – II", Wiley easter. 3. II, T. Arnikar& N. S. Rajurkar, "Nuclear chemistry through problems", New age Int (P) Ltd. 4. E. D. Enger, B. E. Smith, "Environmental Science – A study of Inter relationships", 5th ed., W C B publication.	Recommended Books: 1. Eisenbud, M., & Gesell, T. F. (1997). *Environmental radioactivity from natural, industrial and military sources: from natural, industrial and military sources*. Elsevier. 2. Arnikar, H. J. (1997). Essentials of Nuclear Chemistry: Critique of a review. *Current science*, *72*(5). 3. Arnikar, H. J. (1995). *Essentials of nuclear chemistry* (No. 1653). New Age International. 4. Enger, E. D., Smith, B. F., &Bockarie, A. T. (2000). *Environmental science: A study of interrelationships*. Boston: McGraw-Hill. e-resource(s): https://nptel.ac.in	e-resource has been added
24.	CHE 513 Corrosion Science and Technology	The students will be able to: • Understand the concept of thermodynamics and kinetics of aqueous corrosion • Recognize the factors, forms and affecting parameters of corrosion • Monitor, test and prevent corrosion	**Text books:** 1. Denny A Jones, "Principles and Prevention of Corrosion", Second edition, Prentice Hall Inc., 1996 2. Mars G Fontana, "Corrosion Engineering", Third Edition, McGraw Hill Inc., 1987. **Reference Books:** 1. Kenneth R Trethewey and John Chamberlain, "Corrosion – For Science and Engineering", second edition, Longman Inc., 1996.. 2. Philip A. Schweitzer, "Corrosion and Corrosion Protection Handbook", USA, 1983.	Recommended Books: 1. Jones, D. A. (1992). *Principles and prevention of corrosion*. Macmillan. 2. Fontana, M. G. (2005). *Corrosion engineering*. Tata McGraw-Hill Education. 3. Trethewey, K. R., & Chamberlain, J. (1995). Corrosion for science and engineering. 4. Schweitzer, P. A. (1989). *Corrosion and corrosion protection handbook* (Vol. 1). CRC Press. e-resource(s):	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
				https://nptel.ac.in	
25.	CHE 527 Supercritical Fluid Extraction	The students will be able to: • Understand the properties and chemistry of supercritical fluids • Perform the supercritical fluid extraction process • Develop and apply the strategies of supercritical fluid extraction	**Text books :** 1. Supercritical Fluid Extraction by Larry T. Taylor, Publisher: Wiley-Interscience 2. Supercritical Fluids: Fundamentals and Applications by E. Kiran, Johanna M.H. LeveltSengers, Publisher: Springers. **Reference Books:** 1. Supercritical Fluid Extraction of Nutraceuticals and Bioactive Compounds edited by Jose L. Martinez, Publisher: CRC Press 2. Supercritical fluid extraction: principles and practice by Mark A. McHugh, Val J. Krukonis. 3. Supercritical Fluid Technology in Oil and Lipid Chemistry edited by Jerry W. King, Gary R. List.	Recommended Books: 1. Taylor, L. T. (1996). *Supercritical fluid extraction* (Vol. 4). Wiley-Interscience. 2. Kiran, E., Debenedetti, P. G., & Peters, C. J. (Eds.). (2012). *Supercritical fluids: fundamentals and applications* (Vol. 366). Springer Science & Business Media. 3. Martinez, J. L. (2007). *Supercritical fluid extraction of nutraceuticals and bioactive compounds*. CRC Press. 4. McHugh, M., &Krukonis, V. (2013). *Supercritical fluid extraction: principles and practice*. Elsevier. 5. King, J. W., & List, G. R. (Eds.). (1996). *Supercritical fluid technology in oil and lipid chemistry*. The American Oil Chemists Society.	No changes have been proposed
26.	CHE 510 Catalysis and Surface Chemistry	The students will be able to: • Understand colloids, association of colloids and electro-kinetic effects • Prepare, understand and analyze the properties of catalysis • Characterize, select the catalyst and design the reactor	**Text / Reference Books:** 1 A. Gabor, Somorjai, Li Yimin, "Introduction to Surface Chemistry and Catalysis", 2nd Edition, A Wiley-Interscience Publication, 2010. 2 P. Atkins, J. Paula , "Atkins' Physical Chemistry", 8th Edition, Oxford University Press, Oxford, 2006. 3 Santosh K. Upadhyay, "Chemical Kinetics and Reaction Dynamics" 1st Edition, Anamaya Publishers, 2006. 4 Froment, G.F., Bischoff, K.B., "Chemical Reactor Analysis and Design," 2nd ed,	1. Somorjai, G. A., & Li, Y. (2010). *Introduction to surface chemistry and catalysis*. John Wiley & Sons. 2. Atkins, P. de Paula, J.(2006). *Physical Chemistry 8th edition. Great Britain. Oxford University Press*, *6*, 791-830. 3. Upadhyay, S. K.(2007). *Chemical kinetics and reaction dynamics*. Springer Science & Business Media. 4. Froment, G. F., Bischoff, K. B., &	No changes have been proposed

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
			John-Wiley, New York, 1990. 5 Smith, J. M., "Chemical Engineering Kinetics", 2nd Ed., McGraw-Hill, 1981.	De Wilde, J. (1990). *Chemical reactor analysis and design* (Vol. 2). New York: Wiley. 5. Smith, J. M. (1981). *Chemical engineering kinetics* (No. TP149 S58).	
27.	CHE 408Nano-Science and Technology	The students will be able to: • Understand supra molecular chemistry, self assembly of organic systems and nano materials • Synthesis and process nano material and ultrafine powder • Understand the working principle of nano devices, classify and analyze nano materials using imaging techniques	**Text book (s)** 1. A. Bejan, Advanced Engineering Thermodynamics, 3rd edition, John Wiley and sons, 2006. 2. Stanley I. Sandler, Chemical and Engineering Thermodynamics, Wiley Series in Chemical Engineering, 2002. **Reference book (s)** 1. J. M. Prausnitz, R. N. Lichenthaler and E. G. Azevedo, Molecular Thermodynamics of Fluid-Phase Equilibria, Prentice-Hall Inc., Englewood Cliff, 1986. 2. K. E. Smith and H. C. Van Ness, Introduction to Chemical Engineering Thermodynamics, 3rd ed. New York: McGraw-Hill Book Company, 1975. 3. H. C. Van Ness and M. M. Abbott, Classical thermodynamics of Non-electrolyte solutions, New York: McGraw-Hill Book Company, 1982.	Recommended book(s): 1. Bejan, A. (2016). *Advanced engineering thermodynamics*. John Wiley & Sons. 2. Sandler, S. I. (2017). *Chemical, biochemical, and engineering thermodynamics*. John Wiley & Sons. 3. Prausnitz, J. M., Lichtenthaler, R. N. & de Azevedo, E. G. (1998). *Molecular thermodynamics of fluid-phase equilibria*. Pearson Education. 4. Smith, K. E.& Van Ness, H. C. (1975). *Introduction to Chemical Engineering Thermodynamics*. McGraw-Hill Book Company. 5. Van Ness, H. C. & Abbott, M. M. (1982). *Classical thermodynamics of Non-electrolyte solutions*. McGraw-Hill Book Company. e-resource(s): https://nptel.ac.in	e-resource has been added
24.	CHE 503 Advanced Heat Transfer	The students will be able to: • Understand different types of heat conditions • Be aware of heat transfer with phase change • Design the heat exchangers	Text/Reference Books: 1. Sinnott, R. and Towler, G., "Chemical Engineering Design", Vol. 6, Coulson & Richardson's Chemical Engineering Series, 5th Edition, Elsevier, 2009 2.Holman, J. P., Heat Transfer, Tata	Recommended book(s): 1. Sinnott, R. &Towler, G. (2009).*Chemical Engineering Design Vol.-6.Coulson & Richardson's Chemical Engineering Series*. Elsevier.	e-resource has been added

#	Course List	Learning Outcome	Existing Syllabus	Proposed Syllabus	Remark
			McGraw Publication, 9th Edition, 2002. 3. Tong, L. S., and Tang, Y. S., "Boiling Heat Transfer and Two-Phase Flow", 2nd Edition, Taylor& Francis 1997. 4. S. G. Kandlikar, "Handbook of Phase Change: Boiling and Condensation" Taylor & Francis, 1999.	2. Holman, J. P. (2002).*Heat Transfer*. Tata McGraw Publication. 3. Tong, L. S. &Tang, Y. S. (1997).*Boiling Heat Transfer and Two-Phase Flow*.Taylor& Francis. 4. Kandlikar, S. G. (1999). *Handbook of Phase Change: Boiling and Condensation.* Taylor & Francis. e-resource(s): https://nptel.ac.in	
25.	CHE 516 Environmental Safety and Impact Assessment	The students will be able to: • Develop the basic idea of impact assessment • Able to predict the impact of air, water and noise pollution • Assess and manage the environmental risk	Text Books: 1.Y. Anjaneyulu, Environmental Impact Assessment, B.S Publications, 2003. 2.Attri S. D., Tyagi A.," Climate Profile Of India", Ministry of Earth Sciences, New Delhi. 3.Glasson J., Therivel R., Chadwick A., "Introduction to Environmental Impact Assessment", Routledge- Taylor & Francis Group. Reference Books: 4.Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003. 5.Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science, London, 1999.	Recommended book(s): 1. Anjaneyulu, Y. (2003). *Environmental Impact Assessment.* B.S Publications. 2. Attri S. D. &Tyagi, A. (2010). *Climate Profile of India.* Ministry of Earth Sciences. 3. Glasson, J., Therivel, R. &Chadwick, A. (1998) *Introduction to Environmental Impact Assessment*.Routledge-Taylor & Francis Group. 4. Lawrence, D.P. (2003), *Environmental Impact Assessment – Practical solutions to recurrent problems*. Wiley-Interscience. 5. Petts, J. (1999).*Handbook of Environmental Impact Assessment, Vol., I and II*. Blackwell Science. e-resource(s):	e-resource has been added

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				https://nptel.ac.in	
26.	CHE 306 Computational Methods in Engineering	The students will be able to: • Solve linear and nonlinear algebraic equations • Approximate functional value, integration and ODE • Solve the ODE and PDE	**Text Book(s) :** 1. Gupta, S. K., "Numerical Methods for Engineers," New Age International Ltd., New Delhi, 1995. Reference Book(s) : 1.Hanna, O.T. and Sandall, O.C., "Computational Methods in Chemical Engineering," Prentice-Hall, 1975. 2.Sastry, S.S. "Introductory Methods of Numberical Analysis : PHI 4th Edition	Recommended book(s): 1. Gupta, S. K. (1995). *Numerical methods for engineers*. New Age International. 2. Hanna, O. T., &Sandall, O. C. (1995). *Computational methods in chemical engineering*. Prentice-Hall, Inc.. 3. Sastry, S. S. (2012). *Introductory methods of numerical analysis*. PHI Learning Pvt. Ltd.. e-resource(s): https://nptel.ac.in	e-resource has been added
27.	CHE 317 Advanced Mass Transfer	The students will be able to: • Understand single stage binary distillation • Understand distillation of binary mixture and LLE • Understand leaching and crystallization	**Text/Reference Books:** 1. Seader J. D.; Henly E. J., Separation Processes and Principles, John Wiley, 2010, 3nd edition. 2. Taylor R.; Krishna R., Multicomponent Mass Transfer, John Wiley, 1993. 3. Bendaitez J. Principles and Modern Applications of Mass Transfer Operations, Wiley, 2nd edition, 2011. 4. Holland, C. D. Fundamentals of Multicomponent Distillation, McGraw Hill, 1981. 5. Wankat P. C., Separation Process Engineering, Prentice Hall, 2011, 3nd edition.	Recommended book(s): 1. Seader, J. D., Henley, E. J., & Roper, D. K. (1998). Separation process principles. 2. Taylor, R., & Krishna, R. (1993). *Multicomponent mass transfer* (Vol. 2). John Wiley & Sons. 3. Benitez, J. (2016). *Principles and modern applications of mass transfer operations*. John Wiley & Sons. 4. Holland, C. D. (1981). *Fundamentals of multicomponent distillation*. McGraw-Hill,. 5. Wankat, P. C. (2006).	e-resource has been added

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				Separation process engineering. Pearson Education. e-resource(s): https://nptel.ac.in	
28.	CHE 508 Advanced Transport Phenomena	The students will be able to: • Understand the fundamentals of transport process • Pertain the isothermal, non isothermal and multi-component systems • Analyze the transport equation and computational methods involving multiphase flow	Texts/References: 1. Bird, R.B., Stewart, W.E. and Lightfoot, E.N., "Transport Phenomena", 2nd Edition, John Wiley & Sons, 2002. 2.Deen, W.M.,"Analysis of Transport Phenomena", Oxford University Press, 1st Edition, 2008. 3. Slattery, J. ., "Advanced transport phenomena", Cambridge University Press, 1999. 4. Leal, L. "Advanced Transport Phenomena: Fluid Mechanics and Convective Transport Processes", Cambridge University Press, 2007. 5. Geankoplis C.J. "Transport Processes and Separation Process Principles" Prentice Hall, 2003	Recommended Books: 1. Bird, R. B., Stewart, W. E., & Lightfoot, E. N. (2002). Transport Phenomena 2nd Ed., John Wiley&Sons. *Inc., Hoboken, NJ*. 2. Deen, W. M. (1998). *Analysis of transport phenomena* (Vol. 2). New York: Oxford University Press. 3. Slattery, J. C. (1999). *Advanced transport phenomena*. Cambridge University Press. 4. Leal, L. G. (2007). *Advanced transport phenomena: fluid mechanics and convective transport processes* (Vol. 7). Cambridge University Press. 5. Geankoplis, C. J. (2003). *Transport processes and separation process principles:(includes unit operations)*. Prentice Hall Professional Technical Reference. e-resource(s): https://nptel.ac.in	e-resource has been added

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29.	CHE 521 Natural and Synthetic Polymers	The students will be able to: • Understand the basics of polymer • Understand kinetics of polymerization • Classify polymers, their reinforcement and additives	**Text / Reference Books:** 1. George Odian, Principles of Polymerization, Second Edition, John Wiley & Sons, New York, 1981. 2. Charles E. Carraher, Jr., Sepour/Carraher's Polymer Chemistry, Sixth Edition, Marcel Dekker, Inc., 2003.	Recommended Books: 1. Odian, G. (2004). *Principles of polymerization*. John Wiley &Sons. 2. CarraherJr, C. E. (2007). *Seymour/Carraher's polymer chemistry*. CRC press. e-resource(s): https://nptel.ac.in	e-resource has been added
30.	CHE 526 Processing of Alternative Fuels	The students will be able to: • Predict the future of energy scenario and availability • Understand basic characteristics of alternative fuels including alcohol, biodiesel and gaseous fuels • Realize the importance of electric and solar power vehicles	**Text Book** 1. Alternative Fuels: The Future of Hydrogen; Michael F. HordeskiThe Fairmont Press, Inc., 2008. 2. Alternative Fuels by S.S. Thipse (Author);Jaico Publishing House; First edition (25 November 2010). **Reference Book** 1. Alternative Fuels Guide Book; Bechtold, AR.L. , SAE, 1997. 2. Alternative Fuels: Emissions, Economics, and Performance Timothy T. Maxwell & Jesse C. jones. 3. Handbook of Alternative Fuel Technologies;Sunggyu Lee, James G. Speight, Sudarshan K. Loyalka.	Recommended Books: 1. Hordeski, M. F., &Pansini, A. J. (2007). *Alternative fuels: the future of hydrogen*. The Fairmont Press, Inc.. 2. Thipse, S. S. (2010). Alternative fuels. *Jaico, India*. 3. Bechtold, R. (1997). *Alternative fuels guidebook*. SAE. 4. Maxwell, T. T., & Jones, J. C. (1994). *Alternative fuels. Emissions, economics, and performance* (Vol. 143). 5. Lee, S., Speight, J. G., &Loyalka, S. K. (2014). *Handbook of alternative fuel technologies*. crc Press.	No changes have been proposed
31.	CHE 602R ISO Practices in industries	The students will be able to: • Differentiate various ISO standards • Implement ISO practices in environmental management • Apply ISO standards in energy	**Reference/Text Books:** 1. Singhal D. and Singhal K. R., "Implement ISO9001: 2008 Quality Management System: A Reference Guide", PHI Learning, 2012. 2. Morris A. S., ISO-14000	Recommended Books: 1. Singhal, D., &Singhal, K. R. (2012). *Implement ISO9001: 2008 Quality Management System: A Reference Guide*. PHI Learning Pvt. Ltd..	No changes have been proposed

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		management system	Environmental Management Standards: Engineering and Financial Aspects, Wiley-Blackwell, 2003. 3. Howell M. T. "Effective Implementation of an ISO 50001 Energy Management System (EnMS)"ASQ Quality Press, 2014.	2. Morris, A. S. (2004). *ISO 14000 environmental management standards: engineering and financial aspects*. John Wiley & Sons. 3. Howell, M. T. (2014). *Effective implementation of an ISO 50001 energy management system (EnMS)*. ASQ Quality Press.	
32.	CHE 603R Life Cycle Assessment	The students will be able to: • Get basic idea of life cycle assessment including its goal and scope • Classify and implementation of LCA • Interpret LCA, identify its significant issues, report preparation and review the LCA	Text Books: 1. Curran, Mary Ann. "Life Cycle Analysis: Principles and Practice" , Scientific Applications International Corporation. 2011. Reference books: 1. J. Guinée, ed,"Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards", Kluwer Academic Publishers, 2002. 2. Zbicinski I., StavenuiterJ.,Kozlowska., B., Hennie van de."Covering Product Design and Life Cycle Assessment", The Baltic University Press.	Recommended Books: 1. Scientific Applications International Corporation (SAIC), & Curran, M. A. (2006). *Life-cycle assessment: principles and practice* (pp. 1-80). Cincinnati, Ohio: National Risk Management Research Laboratory, Office of Research and Development, US Environmental Protection Agency. 2. Guinée, J. B. (2002). Handbook on life cycle assessment operational guide to the ISO standards. *The international journal of life cycle assessment*, *7*(5), 311-313. 3. Zbicinski, I. (2006). *Product design and life cycle*	e-resource has been added

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				assessment (Vol. 3). Baltic University Press. e-resource(s): https://nptel.ac.in	
33.	CHE 607R Social Responsibilities in Industries.	The students will be able to: • Understand the scope, value and philosophies of CSR activities • Develop labor communities, techniques and processes in CSR • Work for the betterment of working culture and industrial environment	Suggested Reading: 1. Patterson C. H., "Theories of Counselling and Psycho-therapy", Harper and Raw, New York, 1966. 2. Prasantham, B. J., "Therapeutic Counselling Vellore", ChristionCounselling Centre, 1987. 3. Rimm C. David and Masters C. John, "Behavior Therapy, New York, Academic Press 1974. 4. Veeroraghvan and Vimala, "A Test book of psychotherapy", New Delhi, Starling Publishing. 5. Fried Lender Walter L., "Concept and Methods of social work", Prentice Hall of India, New Delhi, 1977. 6. Mishra, Prayagdeen.,"SamajikVaiyaktiksenakarya", Uttar Pradesh Hindi Sansthan, Lucknow, 1985. 7. Grish Kumar, "SamajKaryaPrakriya", Varanasi, 1974.	Recommended Books: Alao, K. A., Kobiowu, S. V., &Adebowale, O. F. (2010). *Fundamentals of educational and counselling psychology*. Strategic Insight Publishing. e-resource(s): https://nptel.ac.in	e-resource has been added
34.	CHE 501L Advanced Chemical Engineering Lab	The students will be able to: • Understand the kinetics of various kinds of reaction • Determination of COD and BOD • Operate spectrophotometer, HPLC, GC, etc.			No changes have been proposed
35.	CHE 524 Polymer	The students will be able to:	Text / Reference Books:	Recommended Books:	e-resource has

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	Processing and Reaction Engineering	• Get idea about extrusion, blow molding, wire coating etc. and it's affecting parameters • Carry out various molding techniques, problems and their solutions • Understand the methods to achieve polymerization by various reactors	1. Z. Tadmor and C. G., Gogos, "Principles of Polymer Processing" John Wiley and Sons, New York, 1979. 2. D. G. Baird and D. I. Collias, Polymer Processing: Principles and Design" Wiley Inter-science, 1998. 3. Control of Polymerization Reactors, F.JosephSchork, Pradeep B. Deshpande& Kenneth W. Leffew, Marcel Dekker 1993. 4. Reaction Engineering of Step Growth Polymerization, Gupta S. &Anilkumar, Plenum Press, New York 1987. 5. Polymer Reactor Engineering. (C. McGreavy, Ed.) Blackie Academic & Professional, Chapman & Hall 1994,	1. Tadmor, Z., &Gogos, C. G. (1979). Principles of Polymer Processing John Wiley u. *Sons, New York, Brisbane, Chichester, Toronto*. 2. Baird, D. G., &Collias, D. I. (2014). *Polymer processing: principles and design*. John Wiley & Sons. 3. Gupta, S. K., & Kumar, A. (2012). *Reaction engineering of step growth polymerization*. Springer Science & Business Media. e-resource(s): https://nptel.ac.in	been added

Verified

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