Rashtrasant Tukadoji Maharaj Nagpur University

Direction No. 22 of 2014

Direction issued under section 14(8) of the Maharashtra Universities Act, 1994, relating to B.Tech. V & VI Semester for the award of Degree of Bachelor of Technology in Chemical Engineering, Chemical Technology and Biotechnology Full Time in the Faculty of Engineering and Technology.

Whereas, the Maharashtra Universities Act No. XXXV of 1994 has come into force with effect from 22nd July, 1994

AND

Whereas, the amendment to the said Act came to be effected from 12th May, 2000

AND

Whereas, the Board of Studies in General Engineering, Chemical Engineering, Chemical Technology and Biotechnology in the Faculty of Engineering and Technology have decided to make amendment related to V & VI Semester B. Tech. in Credit Based Semester Pattern for award of degree of Bachelor of Technology in Chemical Engineering, Chemical Technology and Biotechnology Full time in the Faculty of Engineering and Technology.

AND

Whereas, the Faculty of Engineering and Technology in its meeting held on 28th May 2014 has considered and approved the V & VI Semester Credit Based Scheme of Examination, Syllabus and Absorption Scheme with the recommendations of the Board of Studies in General Engineering, Chemical Engineering, Chemical Technology and Biotechnology in the Faculty of Engineering and Technology for its implementation from the academic session 2014-15 and onwards.

AND

Whereas, the recommendations made by the Board of Studies in General Engineering, Chemical Engineering, Chemical Technology and Biotechnology as approved by the Vice Chancellor pertains to Examination leading to the B.Tech. (Semester- V and Semester- VI) for award of degree of Bachelor of Technology in Chemical Engineering, Chemical Technology and Biotechnology in the Faculty of Engineering and Technology.

AND

Whereas, it is expedient to provide an Ordinance for the purposes of describing examination in the Credit Based semester pattern leading to the V and VI Semester for the award of Degree of Bachelor of Technology in Chemical Engineering, Chemical Technology and Biotechnology in the Faculty of Engineering and Technology, indicating there in the syllabus and scheme of examination including absorption scheme and C.G.P.A and S.G.P.A.

AND

Now, therefore, I. Anoop Kumar, Vice Chancellor of Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur in exercise of powers vested in me under section 14(8) of the Maharashtra Universities Act, 1994, do hereby issue the following Direction pertaining to the amendment as made for Semester-V and Semester–VI for award of Bachelor of Technology in Chemical Engineering, Chemical Technology and Biotechnology in the Faculty of Engineering and Technology.

1. This Direction shall be called “Direction regarding Credit Based Semester Pattern Scheme and Examination leading to B. Tech. Semester-V and Semester – VI to the Degree of Bachelor of Technology in Chemical Engineering, Chemical Technology and Biotechnology in the Faculty of Engineering and Technology Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur.
2. Subject to the compliance with the provisions of this Direction and any other Ordinance which is in force from time to time shall be applicable

3. The Credit Based Scheme of Examination & Absorption Scheme Appendix for Semester–V and Semester-VI shall be as detailed in the following Table-1

TABLE-1

Sr. No.	**B.Tech. (Branch)**	**Board of Studies**	**Credit Based Scheme of Examinations & Absorption Scheme Appendix**
1.	Chemical Engineering	Chemical Engineering	**A**
2.	Chemical Technology	Chemical Technology	**B**
3.	Biotechnology	Biotechnology	**C**

The A.T.K.T. Rules shall be as given in Table – 2, given below:

TABLE – 2

Admission to Semester	**Candidate should have passed in all subject heads of following examination of the university**	**Candidate should have passed in all subject heads except in 1/3 passing subject heads of the following examination taken together**
I	As per eligibility	---
II	----	---
III	----	I and II Semester
IV	----	I and II Semester
V	I and II Semester	III and IV Semester
VI	I and II Semester	III and IV Semester
VII	III and IV Semester	V and VI Semester
VIII	III and IV Semester	V and VI Semester

4. Students falling under old scheme shall be provided maximum five attempts to clear the subject(s), after which they shall be absorbed in the new scheme.

Whereas, any student willing to opt for New Credit Based Semester Scheme shall be absorbed as per the appendices mentioned in **Table-1** at equivalent Credit Based Semester Scheme level. However, student will have to appear for the examinations under Credit Based Semester Scheme for the subjects in which student has not cleared the subject in Yearly Pattern Scheme

5. (i) The Scope of subject shall be as indicated in the syllabus.

(ii) The medium of instruction and examination shall be English.

6. The provisions of Ordinance No. 3 of 2007 relating to the award of grace marks for passing an examination or for securing higher division/class and for securing distinction in subject(s) as updated from time to time shall apply to the examination under this ordinance.

7. An Examinee who does not pass or who fails to present himself/herself for the examination(s) shall be eligible for **reappearing** in the same examination on payment of a fresh fee and as such other fees as may be prescribed from time to time. However, **readmission** to semester should be allowed only when a regular session is running for a particular semester.

8. The computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of an examinee shall be implemented progressively as from the academic session 2014-15 onwards.

The marks will be allotted in all examinations which will also include college assessment marks. The total marks for each Theory/Practical subject head shall be converted into Grade points as per **Table - 3.**

SGPA shall be calculated based on Grade Points earned corresponding to percentage of marks as given in **Table - 3** and the Credits allotted to respective Theory/Practical subject head shown in the scheme of examination for respective semester.

9. SGPA shall be computed for every semester and CGPA shall be computed only in VIII semester. The CGPA of VIII semester shall be calculated based on **SGPA** of V to VIII semester as per following computation:-

$$\text{SGPA} = \frac{\sum_{i=1}^{m} Ci.Gi}{\sum_{i=1}^{m} Ci} = \frac{C1.G1 + C2.G2 + \ldots.. + Cm.Gm}{C1 + C2 + \ldots\ldots + Cm}$$

Where, m = Number of subject heads in a given Semester.

$$\text{CGPA} = \frac{\sum_{j=1}^{n} Cj.Gj}{\sum_{j=1}^{n} Cj} = \frac{C1.G1 + C2.G2 + \ldots.. + Cn.Gn}{C1 + C2 + \text{-------} + Cn}$$

Where, n = Number of subject heads from V to VIII Semester taken together.

Ci or Cj = Credit of individual subject head (Theory/Practical).

Gi or Gj = Grade Point earned in individual subject head (Theory/practical).

10. CGPA equal to 6.75 and above shall be considered as equivalent to First Division and CGPA equal to 8.25 and above shall be considered as equivalent to Distinction on Grade Card of VIII Semester as a foot note. Equivalent percentage calculation will be based on the following formula:

Equivalent % = (CGPA – 0.75) x 10

TABLE-3

THEORY			PRACTICAL		
Grade	**Percentage of Marks**	**Grade Points**	**Grade**	**Percentage of Marks**	**Grade Points**
AA	80 ≤Marks≤ 100	10	AA	85 ≤Marks≤ 100	10
AB	70 ≤Marks< 80	9	AB	80 ≤Marks< 85	9
BB	60 ≤Marks< 70	8	BB	75 ≤Marks< 80	8
BC	55 ≤Marks< 60	7	BC	70 ≤Marks< 75	7
CC	50 ≤Marks< 55	6	CC	65 ≤Marks< 70	6
CD	45 ≤Marks< 50	5	CD	60 ≤Marks< 65	5
DD	40 ≤Marks< 45	4	DD	50 ≤Marks< 60	4
FF	00 ≤Marks< 40	0	FF	00 ≤Marks< 50	0
ZZ	Absent in Examination	-	ZZ	Absent in Examination	-

11. As Soon as possible, after the examination, the Board of Examinations shall publish a list of successful examinees and the Degree shall be awarded based on V to VIII Semester SGPA and CGPA calculated thereon.

12. I, further directed that the aforesaid Direction shall come into force from the date of issuance and shall remain in force till the relevant Ordinance comes into being in accordance with the provisions of Maharashtra Universities Act, 1994 and the relevant provisions published by this Direction shall be physically repealed from the existing Ordinance.

Sd/-

. (Anoop Kumar)

Vice Chancellor

Nagpur:

Dated::18/6/2014

APPENDI X – A
SCHEME OF EXAMINATION
RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FIFTH SEMESTER B.TECH (CHEMICAL ENGINEERING)

Sr. No.	Code Theory (T) Practical (P)	Subject	Board	Teaching Scheme, hr.				Credit				MARKS				**Total Marks**
												Theory		Practical		
				L	P	T	Total	L	P	T	Total	Sessional	University	Sessional	University	
1.	BTCHE 501T	Fluid Mechanics	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
2.	BTCHE 502T	Chemical Engineering Thermodynamics	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
3.	BTCHE 503T	Mass Transfer	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
4.	BTCHE 504T	Heat Transfer	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
5.	BTCHE 505T	Biochemical Engineering	BCHE	3	-	-	3	3	-	-	3	20	80	-	-	**100**
6.	BTCHE 506P	Fluid Mechanics	BCHE	-	3	-	3	-	2	-	2	-	-	25	25	**50**
7.	BTCHE 507P	Mass Transfer	BCHE	-	3	-	3	-	2	-	2	-	-	25	25	**50**
8.	BTCHE 508P	Heat Transfer	BCHE	-	3	-	3	-	2	-	2	-	-	25	25	**50**
			Total	**15**	**9**	**4**	**28**	**15**	**6**	**4**	**25**	**100**	**400**	**75**	**75**	**650**

SCHEME OF EXAMINATION
RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
SIXTH SEMESTER B.TECH (CHEMICAL ENGINEERING)

Sr. No.	Code Theory (T) Practical (P)	Subject	Board	Teaching Scheme, hr.				Credit				MARKS				**Total Marks**
												Theory		Practical		
				L	P	T	Total	L	P	T	Total	Sessional	University	Sessional	University	
1.	BTCHE 601T	Separation Processes	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
2.	BTCHE 602T	Environmental Engineering	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
3.	BTCHE 603T	Process Equipment Design	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
4.	BTCHE 604T	Chemical Reaction Engineering	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
5.	BTCHE 605T	Elective-I	BCHE	3	-	-	3	3	-	-	3	20	80	-	-	**100**
6.	BTCHE 606P	Environmental Engineering	BCHE	-	3	-	3	-	2	-	2	-	-	25	25	**50**
7.	BTCHE 607P	Process Equipment Design	BCHE	-	3	-	3	-	2	-	2	-	-	25	25	**50**
8	BTCHE 608P	Separation Processes	BCHE	-	3	-	3	-	2	-	2	-	-	25	25	**50**
8.	BTCHE 609P	Minor Project	BCHE	-	2	-	2	-	1	-	1	-	-	50	-	**50**
			Total	**15**	**11**	**4**	**30**	**15**	**7**	**4**	**26**	**100**	**400**	**125**	**75**	**700**

Elective	Subject Name				
	BOARD				
	BTCHE				
Elective-I	1.Human Behavior in Organization	2. Materials Management	3. Marketing Management	4. Advanced Materials	5. Renewable Energy Sources

Scheme of Absorption for Old Pattern to Semester Pattern of 5th Semester B. Tech. (Chemical Engineering)							
As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern)					As Per Rashtrasant Tukadoji Maharaj Nagpur University Credit Based Semester Pattern Scheme		
Fifth Semester B. Tech (Chemical Engineering)					Fifth Semester B. Tech (Chemical Engineering)		
Sr. No.	**Sub Code Theory/ Practical**	**Subject**	**Theory/ Practical**		**Sub Code Theory/ Practical**	**Subject**	**Theory/ Practical**
1	5SCE1 (BChE)	Fluid Mechanics	Theory		BTCHE 501T	Fluid Mechanics	Theory
2	5SCE2 (BChE)	Chemical Engineering Thermodynamics	Theory		BTCHE 502T	Chemical Engineering Thermodynamics	Theory
3	------	------			BTCHE 503T	Mass Transfer*	Theory
4	------	------			BTCHE 504T	Heat Transfer*	Theory
5	5SCE3 (BChE)	Environmental Eng. and Biotechnology	Theory		BTCHE 505T	Biochemical Engineering	Theory
6	5SCE4 (BChE)	Applied Mathematics III	Theory		------	------	
7	5SCE5 (BChE)	Plant Design –I	Theory		------	------	
8		Fluid Mechanics	Practical		BTCHE 506P	Fluid Mechanics	Practical
9		------	------		BTCHE 507P	Mass Transfer**	Practical
10		------	------		BTCHE 508P	Heat Transfer**	Practical
11		Industrial Waste Treatment	Practical		------	------	

*** Students to appear in university theory examination as per the new scheme**
**** Students to appear in university practical examination as per the new scheme**

Scheme of Absorption for Old Pattern to Semester Pattern of 6th Semester B. Tech. (Chemical Engineering)							
As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern)					As Per Rashtrasant Tukadoji Maharaj Nagpur University Credit Based Semester Pattern Scheme		
Sixth Semester B. Tech (Chemical Engineering)					Sixth Semester B. Tech (Chemical Engineering)		
Sr. No.	**Sub Code Theory/ Practical**	**Subject**	**Theory/ Practical**		**Sub Code Theory/ Practical**	**Subject**	**Theory/ Practical**
1	6SCE1 (BChE)	Organic Chemical Process Industries	Theory		------	------	
2	------	------			BTCHE 601T	Separation Processes*	Theory
3	------	------			BTCHE 602T	Environmental Engineering*	Theory
4	------	------			BTCHE 603T	Process Equipment Design*	Theory
5	6SCE2 (BChE)	Heat Transfer	Theory		------	------	
6	6SCE 3 (BChE)	Mass Transfer – I	Theory		------	------	
7	6SCE4 (BChE)	Chemical Reaction Engineering- I	Theory		BTCHE 604T	Chemical Reaction Engineering	Theory
8	6CSE5 (BChE)	Process Control – I	Theory		------	------	
9	------	********			BTCHE 605T	Elective-I$	Theory
10	------	------			BTCHE 606P	Environmental Engineering**	Practical
11	------	------			BTCHE 607P	Process Equipment Design**	Practical
12	------	------			BTCHE 608P	Minor Project**	Practical
13		Heat Transfer	Practical		------	------	
14		Organic Chemical Technology	Practical		------	------	
15		Instrumental Methods of Analysis	Practical		------	------	

*** Students to appear in university theory examination as per the new scheme**

**** Students to appear in university practical examination as per the new scheme**

$ This subject is exempted

APPENDIX – B
SCHEME OF EXAMINATION
B. TECH (CHEMICAL TECHNOLOGY)
FIFTH SEMESTER B.TECH (CHEMICAL TECHNOLOGY)

Sr. No	Code Theory (T) Practical (P)	Subject	Board	Workload				Credit				MARKS				Total Marks
												Theory		Practical		
				L	P	T	Total	L	P	T	Total	Sessional	University	Sessional	University	
1.	BTCHT501T	Fluid Flow Operation	BCHT	3	-	1	4	3	-	1	4	20	80	-	-	100
2.	BTCHT502T	Solid Fluid Operations	BCHT	3	-	-	3	3	-	-	3	20	80	-	-	100
3.	BTCHT503T	Chemical Equipment Design	BCHT	3	-	1	4	3	-	1	4	20	80	-	-	100
4.	BTCHT 504T	Process Plant Utilities	BGE	3	-	-	3	3	-	-	3	20	80	-	-	100
5.	BTCHT505T	*Special Technolog-III	BCHT	3	-	1	4	3	-	1	4	20	80	-	-	100
6.	BTCHT506P	Fluid Flow Operation	BCHT	-	3	-	3	-	2	-	2	-	-	25	25	50
7.	BTCHT507P	Solid Fluid Operations	BCHT	-	3	-	3	-	2	-	2	-	-	25	25	50
8.	BTCHT508P	Chemical Equipment Design	BCHT	-	3	-	3	-	2	-	2	-	-	25	25	50
Total				15	9	3	27	15	6	3	24	100	400	75	75	650

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- Food Technology
- Technology of Oils, Fats and Surfactants
- Petroleum Refining and Petrochemical Technology
- Pulp & Paper Technology
- Plastics & Polymer Technology
- Surface Coating Technology

SCHEME OF EXAMINATION
B. TECH (CHEMICAL TECHNOLOGY)
SIXTH SEMESTER B.TECH (CHEMICAL TECHNOLOGY)

Sr. No.	Code Theory (T) Practical (P)	Subject	Board	Workload				Credit				MARKS				Total Marks
												Theory		Practical		
				L	P	T	Total	L	P	T	Total	Sessional	University	Sessional	University	
1.	BTCHT 601T	Process Engineering Thermodynamics	BCHT	3	-	1	4	3	-	1	4	20	80	-	-	100
2.	BTCHT602T	Heat Transfer Operations	BCHT	3	-	1	4	3	-	1	4	20	80	-	-	100
3.	BTCHT603T	Chemical Process Control	BCHT	3	-	-	3	3	-	-	3	20	80	-	-	100
4.	BTCHT604T	Environmental Engineering	BCHT	3	-	1	4	3	-	1	4	20	80	-	-	100
5.	BTCHT605T	*Special Technology IV	BCHT	3	-	1	4	3	-	1	4	20	80	-	-	100
6.	BTCHT606P	Heat Transfer Operations	BCHT	-	3	-	3	-	2	-	2	-	-	25	25	50
7	BTCHT607P	Environmental Engineering	BCHT	-	3	-	3	-	2	-	2	-	-	25	25	50
8.	BTCHT608P	*Special Technology II	BCHT	-	3	-	3	-	2	-	2	-	-	25	25	50
9.	BTCHT 609P	Minor Project	BCHT	-	2	-	2	-	1	-	1			50	--	50
Total				15	11	4	30	15	7	4	26	100	400	125	75	700

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- Food Technology
- Technology of Oils, Fats and Surfactants
- Petroleum Refining and Petrochemical Technology
- Pulp & Paper Technology
- Plastics & Polymer Technology
- Surface Coating Technology

Scheme of Absorption for Old Pattern to Semester Pattern of Third Year B. Tech. (Chemical Technology)

As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) Fifth Semester B. Tech (Chemical Technology)				As Per Rashtrasant Tukadoji Maharaj Nagpur University Credit Based Semester Pattern Scheme Fifth Semester B. Tech (Chemical Technology)		
Sr. No	**Sub Code Theory/ Practical**	**Subject**	**Theory Practical**	**Sub Code Theory/ Practical**	**Subject**	**Theory Practical**
1	5S.CT.1 (BChE)	Fluid Mechanics and Mechanical Operations	Theory	BTCHT 501T (BCHT)	Fluid Flow Operation	Theory
2				BTCHT 502T (BCHT)	Solid Fluid Operations	Theory
3	5S.CT.2 (BChE)	Plant Design	Theory	BTCHT 503T (BCHT)	Chemical Equipment Design	Theory
4	---	-----	---	[1]BTCHT 504T (BGE)	Process Plant Utilities	Theory
5	5S.CT.3 (BChE)	Heat Transfer	Theory	---	-----	---
6	5S.CT.4 (BGE)	Organic Chemical Process Industries	Theory	---	-----	---
7	5S.CT.5 (BCT)	Special Technology III	Theory	BTCHT 505T (BCHT)	Special Technology III	Theory
8	5S.CT.6 (BChE)	Unit Operations	Practical	BTCHT 506P (BCHT)	Fluid Flow Operation	Practical
9				BTCHT507P (BCHT)	Solid Fluid Operations	Practical
10	------	--------	--------	BTCHT508P (BCHT)	Chemical Equipment Design	Practical
11	5S.CT.7 (BChE)	Heat Transfer	Practical	--------	---------	--------
12	5S.CT.8 (BGE)	Organic Chemical Technology	Practical	---------	---------	--------

[1]Subject is covered in Fourth Semester for Old Pattern according to subject (4S.CT.2) Plant Utilities (Theory). They may be exempted.

Scheme of Absorption for Old Pattern to Semester Pattern of Third Year B. Tech. (Chemical Technology)

As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) Sixth Semester B. Tech (Chemical Technology)				As Per Rashtrasant Tukadoji Maharaj Nagpur University Credit Based Semester Pattern Scheme Sixth Semester B. Tech (Chemical Technology)		
Sr. No	**Sub Code Theory/ Practical**	**Subject**	**Theory Practical**	**Sub Code Theory/ Practical**	**Subject**	**Theory Practical**
1	6S.CT.1 (BGE)	Applied Mathematics III	Theory	---	-----	---
2	6S.CT.2 (BChE)	Mass Transfer	Theory	---	-----	---
3	6S.CT.3 (BChE)	Environmental Engineering and BioTechnology	Theory	BTCHT 604T (BCHT)	Environmental Engineering	Theory
4	6S.CT.4 (BChE)	Chemical Engineering Thermodynamics	Theory	BTCHT 601T (BCHT)	Process Engineering Thermodynamics	Theory
5	6S.CT.5 (BCT)	Special Technology IV	Theory	BTCHT 605T (BCHT)	Special Technology IV	Theory
6	6S.CT.6 (BChE)	Mass Transfer	Practical	---	-----	---
7	6S.CT.7 (BGE)	Industrial Waste Treatment	Practical	---	-----	---
8	6S.CT.8 (BCT)	Special Technology II	Practical	BTCHT 608P (BCHT)	Special Technology II	Practical
9	---	-----	---	BTCHT 603T (BCHT)	Chemical Process Control	Theory
10	---	-----	---	[1]BTCHT 602T (BCHT)	Heat Transfer Operations	Theory
11	---	-----	---	[2]BTCHT 606P (BCHT)	Heat Transfer Operations	Practical
				BTCHT607P (BCHT)	Environmental Engineering	Practical
12	---	-----	---	BTCHT 609P (BCHT)	Minor Project	Practical

[1]Subject is covered in Fifth Semester for Old Pattern according to subject (5S.CT.3) Heat Transfer (Theory). They may be exempted.

[2]Subject is covered in Fifth Semester for Old Pattern according to subject (5S.CT.7) Heat Transfer (Practical). They may be exempted

Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Engineering & Technology
Syllabus for
Fifth Semester B.Tech. Chemical Technology

Subject:BTCHT501T (BCHT) **Fluid Flow Operation**
(Theory)
Lecture: 3 Hours No. of Credits: 4
Tutorial: 1 Hour University: 80 Marks
Duration of Examination: 3 Hours College Assessment: 20 Marks

UNIT 1: Classification of fluid mechanics, Properties of fluids, Classification of fluids, Shearing and flow, characteristics of Newtonian and Non-Newtonian fluids, Shear stress distribution of fluids, Pressure measurement, U-tube, Inverted U-tube, Differential and Inclined manometers, Reynolds number, Friction factor

UNIT 2 : Bernoulli`s equation, Frictional loss in pipe, Continuity equation, Velocity distribution for, laminar flow and turbulent flow, Hydraulic mean diameter, losses due to enlargement and contraction of pipe cross - section.

UNIT 3 : Equivalent length of pipe, Pipe fittings, Gate , Globe, Check and Butterfly valves, Boundary layer development, Two-phase flow, Flow patterns in two phase flow. The Baker diagram, Erosion in two phase flow.

UNIT 4 : Flow rate measurement, Working principle and expressions for flowrate through Pitot tube, Orifice meter, Venturimeter, Nozzle, Rotameter, Notch and Weir, Coefficient of discharge, Wet gas flowmeter, Pressure recovery in Orificemeter, Venturimeter and Nozzle.

UNIT 5 : Pumping of fluids, Classification of pumps, Positive displacement pumps, Reciprocating, Pump, Plunger pump, Diaphragm pump, Metering pump, Rotary gear pump, Rotary lobe Pump, Rotary vane pump, Flexible vane pump, Mono pump, Cetrifugal pump, Volute pump, Volute pump with vortex chamber and diffuser vanes, Cavitation, Priming,Net positive suction head ,Multistage centrifugal pumps. Specific speed and operating characteristics of centrifugal pump.

UNIT 6 : Fluid flow in packed column, Classification of packings, Characteristics of packing material, Loading and flooding in packed column,Specific surface of packed column, Permeability coefficient, Modified Reynolds number, Modified friction factor, Kozeny`s,Carman`s, Sawistowski`s and Ergun`s equations for packed column. Characteristics of fluidization, Aggregative and particulate fluidization, Incipient fluidization velocity, equations for pressure drop across fluidized column, Applications of packed and fluidized column.

Books Recommended:

1. R. P. Vyas, Fluid Mechanics, Second edition, Denett & Co. Publication, 2008.

2. J.M. Coulson, J.F. Richardson with J.R. Backhurst, J.H. Harker, Chemical Engineering Vol. I: Fluid Flow, Heat Transfer and Mass Transfer, Sixth Edition, Butterworth-Heinemann an imprint of Elsevier
3. J.M. Coulson, J.F. Richardson with J.R. Backhurst, J.H. Harker, Chemical Engineering Vol. II: Particle Technology and Separation Processes, Fifth Edition, Butterworth-Heinemann an imprint of Elsevier
4. G.G. Brown, Unit Operations, CBS Publishers Pvt. Ltd, 2005.
5. W.L. Badger, J.T. Banchero, Introduction to Chemical Engineering, Tata McGraw Hill Education, 1997.
6. W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill Publication, 2005.

Subject:BTCHT502T (BCHT) **Solid Fluid Operation (Theory)**

Lecture: 3 Hours
Tutorial: -----
Duration of Examination: 3 Hours

No. of Credits: 3
University: 80 Marks
College Assessment: 20 Marks

Unit I: Solids

Properties of solids, screening, screening equipments, effectiveness of screens, sieve analysis, average diameter and specific surface. Size reduction, types of equipments used in the various stages of reductions. Laws of crushing & grinding power requirements.

Unit II: Handling of solids

Belt conveyer, screw conveyer, flight conveyers, bucket conveyer, pneumatic conveyers. Capacity and power requirements of conveyers. Flow of solids through fluids, terminal settling velocity & hindered settling.

Unit III: Classification

Principles of classification, and jigging, equipments, tabling, magnetic and electrostatic separation, cyclone separation, theory, principle and their design. Flotation cells and calculations for flotation process.

Unit IV: Filtration

Filtration theory, equipment for filtration, constant pressure and constant rate filtration, filter calculations, optimum cycle time & filter aids.

Unit V: Sedimentation

Laboratory batch sedimentation Kynech theory , calculation of area and depth for continuous thickeners. Centrifugation principles of a centrifuge, sedimentation, equipments and calculations.

Unit VI: Mixing and Agitation

Theory of mixing and agitation, types of equipment, mixing characteristics, power consumption, mixing index, rate of mixing.

Text Books:

1) Unit operation by Brown G.G., CBS Publishers First Edition 1995, Reprint 2005.
2) Introduction to Chemical Engineering by Badger W.L. and Banchero J.T. McGraw-Hill 1955.

References Books:

1) Unit operations for chemical engineers by McCabe W.L. and Smith J.C. Mc Grow Hill International Edition Seventh Edition 2005.
2) Chemical Engineering by Coulson J.N. and Richardson R.F., Butterworth Heinemann Vol. I Sixth Edition1999.
3) Chemical Engineering by Coulson J.N. and Richardson R.F., Elsevir Publication Vol. II Fifth Edition 2002.
4) Unit Operations of Chemical Engineering by Hiramath R.S., Kulkarni A.P. Everest Publications 3rd Edition 2004.
5) Transport Processes and Separation Process Principles by Christe John Geankoplis, PHI Learning, Fourth Edition 2003.

Subject:BTCHT503T (BCHT) **Chemical Equipment Design**

(Theory)

Lecture: 3 Hours
Tutorial: 1 Hour
Duration of Examination: 3 Hours

No. of Credits: 4
University: 80 Marks
College Assessment: 20 Marks

Unit I: Introduction to Principles of Design

Nature of process equipments, general design procedure, basic considerations in design, standards, codes, and their significance, equipment classification and their selection, design pressure, design temperature, design stress, review of fabrication techniques and environmental considerations in design procedure. Principal stresses, theories of failure . Materials of construction and selection for process equipments, linings and coatings for equipments.

Unit II: Pressure Vessel

Proportioning of pressure vessels, selection of L/D ratio, optimum proportions of vessels. Design of unfired pressure vessels subjected to combined loading, purging of vessels.

Selection and design of various heads such as flat, hemispherical, torispherical, elliptical and conical, Opening/ nozzles, manholes, Nozzle reinforcement design, etc. Flanged joints, classification of flanges, design of non standard flanges, types of Gaskets their selection, and design. Bolt design and selection.

Unit III: Design of Pressure Vessels Subjected To External Pressure and High Pressure Vessels

Pressure vessels subjected to external pressure: Design of shell, heads, nozzles, flanged joint, stiffening rings.

Design of thick cylinder, pre-stressing, Analysis and design of high pressure vessels: monoblock and compound (multilayer), etc.

Unit IV: Vessel Support

Introduction and classification of supports, design of skirt supports, stresses due to dead weight, wind load, seismic load, and period of vibration, design of base plate, skirt, bearing plate, anchor bolts, bolting chairs, design of bracket supports. Design of saddle supports, ring stiffeners, etc.

Unit V: Storage Vessels

Various types of storage vessels and applications, Atmospheric vessels, vessels for storing volatile and nonvolatile liquids, storage of gases, Losses in storage vessels, Various types of roofs used for storage vessels, manholes, nozzles and mountings. Design of cylindrical and spherical storage vessels; should include

base plates, shell plates, roof plates, wind girders, curb angles for self supporting and column supported roofs.

Unit VI: Agitators and Reaction Vessels

Types of agitators, their selection, applications, baffling, power consumption which includes twisting moment, equivalent bending moment, design of blades etc.

Reaction vessels- Introduction, classification, heating systems, design of vessels, study and design of various types of jackets like plain, half coil, channel, limpet oil. Study and design of internal coil reaction vessels, Heat transfer coefficients in coils.

Books Recommended:

1. S. D. Dawande, Process Equipment Design, Denett & Co, 2009
2. M.V. Joshi, V. V. Mahajani, Process Equipment Design, Macmillan India.
3. B.C. Bhattacharya, Introduction to Chemical Equipment Design, CBS Publications, 1985.
4. J. M. Coulson, J. F. Richardson, R. K. Sinnott, Chemical Engineering Vol. 6 - Design, Pergamon Press, 1983.
5. E.E. Ludwig, Applied Process Design for Chemical and Petrochemical Plants, Vol. 1 and 2, Gulf Publishing Co., 1997.
6. S. M. Walas, Chemical Process Equipment: Selection and Design, Butterworth-Heinemann, 1990.
7. L. E. Brownell, E. H. Young, Process Equipment Design - Vessel Design, John Wiley and Sons, Inc., 1959.
8. Indian standards Institution, 'Code for unfired pressure vessels', IS – 2825.

Subject:BTCHT504T (BCHT) **Process Plant Utilities (Theory)**

Lecture: 3 Hours
Tutorial: -----
Duration of Examination: 3 Hours

No. of Credits: 3
University: 80 Marks
College Assessment: 20 Marks

Unit I: Thermodynamics

Laws of perfect gases, thermodynamics processes, First and Second Law of thermodynamics, Entropy,The clausius inequality, Steady Flow Processes, carnot Cycle.

Unit II: Steam Generators

General Description, Boiler Mounting and Accessories, Natural and Artificial Draught, Equivalent Evaporation and Thermal efficiency.Design of chimney. Constructional details and design aspects.

Unit III: Turbine

Theory and working of impulse, reaction and gas turbine. Bleeding and reheating.

Unit IV: Internal Combustion Engine

Cycle of operation, two and four stroke cycle, general description of S.I and C. I. engines, ignition, injection and governing.Cooling of I C Engine.

Unit V: **Properties of Steam**

Use of steam tables, measurement of dryness fraction, entropy of steam, temperature entropy and mollier charts, clausius clapeynon equation, Rankine Cycle.

Unit VI: Refrigeration

Introduction to refrigeration, various cycles, coefficient of performance. Applications of refrigeration.

Text Books:

1. Engineering Thermodynamics , P. K. Nag, McGraw Hill Education (India) Ltd
2. Thermal Engineering, R. K. Rajput

Reference Books:

1. Fundamental of Engineering Thermodynamics – John and Howel
2. THERMODYNAMICS An Engineering Approach – Y.A. Cengel and M.A. Boles
3. Applied Thermodynamics – Aestop
4. Applied Thermodynamics – R N Joel

Subject:BTCHT505T (BCHT) **Special Technology-III (Theory)**

Lecture: 3 Hours
Tutorial: 1 Hour
Duration of Examination: 3 Hours

No. of Credits: 4
University: 80 Marks
College Assessment: 20 Marks

BTCHT505T/1 Food TechnologyIII (Theory)
(Microbiology and Molecular Biology)

Unit 1: Historical background of microbiology. Classification of microorganisms. Structure of typical bacterial cell. Study of bacteria, yeasts, molds and actinomyces with respect to morphology, physiological requirements, reproduction. Introduction to viruses.

Unit 2: Nutritional requirements of microorganisms. Autotrophic and heterotrophic mode of nutrition. Composition of nutrient media. Comparison of natural, synthetic, differential, selective and enrichment media. Methods of isolation and characterization of microorganisms.

Unit 3: Growth of microorganisms. Phases of growth curve. Specific growth rate and generation time. Synchronized and balanced growth. Enumeration of microorganism. Bacteriological analysis of food and water. Food borne diseases and food poisoning. Microbial toxins.

Unit 4: Effect of temperature on growth of microorganisms. D_{10} value, F value, Z value and TDT curve. Control of microorganisms by high and low temperature. Structure and operation of autoclave. Sterilization by dry and moist heat.

Unit 5: Control of microorganisms by physical and chemical methods. Effect of water activity, irradiation and chemicals on growth of microorganisms. Preservation by chemicals – Role of chemicals in food preservation. Classification of preservatives and their role in various food. Method of evaluation of antimicrobial agents. Microbial Quality assurance system in food industry. Detection methods for *E.coli, Staphylococci, Clostridium botulinum, Salmonella* in food samples.

Unit 6: Structure and functions of nucleic acids. DNA replication and protein biosynthesis. Genetic code. Mutations and mutagens. Identification and isolation of mutants. Introduction to fermentation processes. Types of fermentation. Role of microorganisms in fermentation.

Books Recommended:

1. Microbiology, Vol I & II by C B Powar and H F Daginawala
2. Microbiology by M J Pelczar, R D Reid and C S Chan, Tata McGraw Hill Pub.Co, Ltd, New Delhi
3. Food Microbiology by W C Frazier, Tata McGraw Hill Pub.Co.Ltd., New Delhi

BTCHT 505T/2 Oil Technology III (Theory)
(Technology of Oils and Oil bearing materials)

Unit 1: Natural sources of oils and fats

Domestic and world production of oil seeds and oils, handling, drying, storage, sampling and grading, pretreatment of oil seeds prior to oil extraction. Mechanical extraction of oil seeds, plants and processes involved newer methods in extraction of oil seeds.

Unit 2: Processing of oils and fats

Plants and processes employed for recovery of oils and fats by solvent extraction, solvents, their availability and selection, advantages and limitations, refining, bleaching and deodorization of oils and fats, batch and continuous plants and processes, recent trends.

Unit 3: Processing of oils and fats

Hydrogenation oils and fats, pretreatment prior to hydrogenation , methods of production and analysis of hydrogen gas and nickel catalyst for hydrogenation. Different methods of hydrogenation, their advantages and disadvantages. Quality control in hydrogenated products. Designing and processes engineering aspects of hydrogenation.

Unit 4: Processing of oils and fats

Manufacture of butter, ghee, margarine and Transesterified oils and fats, winterization of oils, cooking and salad oils, plastic shortening agents. Confectionary fats and their Characteristics,

Unit 5: Up gradation of oilseeds and oils

General methods of upgrading and utilization of oils and fats, Oil Seed Proteins and Byproduct Utilization, oil cakes and allied products. Detoxification of oilseed and oil meal, Chemical composition of oilseed, utilization of oilseed meal, isolation of proteins and processing of protein products.

Unit 6: Lipid Associates and Applications of non-traditional oils such as Karanja, Neem, Mahua, Sal, Rubber seed, Jojoba, Jatropha, Kokum etc., Fish Oils, Rendering of Animal Fats. Membrane Processing of Fats and Oils, Utilization of waste products from oil processing industries.

Reference Books:

1. Refining of Oils& Fats, Anderson, A. J. C, The MacMillan Co., New York.
2. Fats and Oils, D O'Brien, Third Edition, CRC Press,London
3.Bailey’s Industrial Oil and Fat Products, 6 Volumes, Wiley-Interscience Publication,New York

4. Confectionary fats Handbook, Timms, R. E. The Oily Press Lipid Library, UK
5. Practical Short Course on Processing and Products of Vegetable Oil / Biodiesel ,College Station, Texas,Held on October 18-22, 2009
6. Vegetable Oils in Food Technology (Chemistry and Technology of Oils and Fats), Frank Gunstone, Wiley Blackwell; USA
7. Edible Oils and Fats--A Global Overview of Technological Developments, Guinness Centre, Taylors Lane,, Ireland.
8. Seed Structure and Anatomy, the Seed Biology Place, Gerhard, Leubner, Germany

BTCHT505T/3 Petroleum Refining and Petrochemical Technology III (Chemistry of Hydrocarbons & Speciality Products)

Unit1: Low & high molecular weight paraffin's, olefins, aromatics, naphthenes & dienes. Their thermodynamic stability & reactivity & their relationship with performance characteristics.

Unit 2: Zeolite synthesis reaction, unit cell structure, classification, acidity & basicity in zeolites, cation exchange, dealumination & isomorphous substation principles.

Unit 3: Applications of zeolites in catalysis & in separation processes with few case studies.

Unit 4: General information on intermediate and final chemicals obtainable from natural gas, naphtha etc. & their processing strategy. Naphtha and gas cracking to produce C_1-C_4 Olefins, Dienes and Aromatics.

Unit 5: Lubricating oils, specifications, characteristics, production of lube specialities, additives, refining of lubricating oil-solvent chemicals & hydrogenation method, dewaxing, deasphalting etc. Re-refining of lubricating oil.

Unit 6: Petroleum speciality products like grease, waxes. Manufacture of specialty oils viz. Insulating oil, transformer oil, white oil, etc.
Asphalt & asphalt specialties, air blowing & emulsification techniques.

Books Recommended:

1. Modern Petroleum Technology by G.D. Hobson
2. Chemicals from Petroleum by L. Waddams
3. Zeolite Molecule Sieves: Structure, Chemistry & Use by W.D.Breek, A Willy International Publication.
4. Chemistry & Technology of Basic Organic & Petrochemical Synthesis Vol 1 & Vol 2 by N.N. Lebdev, Mir Publishers MOSCOW.
5. Zeolite synthesis, American Chemical Society Symposium Series by L. Occelli, ACS, (Ed) & Roboson H.E., Washington DC.

BTCHT 505T/4 **Pulp and Paper Technology III**
(Pulping Processes III)

Unit 1: Refiner Mechanical Pulping Process, pulp properties and uses, single-stage and two-stage processes, plate designs, steam cooking. Thermomechanical Process, variables, pulp characteristics and applications.

Unit 2: Hot sulfite chemimechanical process, variables, properties and uses, chemigroundwood pulping, applications, properties and uses.

Unit 3: Pulping of non-woody fibres : batch and continuous processes, recovery of chemicals, bleaching of non-woody fiber pulps, dissolving grade pupls.

Unit 4: Rags in paper making, collection, sorting, use of cotton linters in pulping, pulp characteristics and uses.

Unit 5: Secondary fibers, classification, deinking, processes and chemicals, ink grades, bleaching, shrinkage and yield values.

Unit 6: Environment friendly technologies for the pulp and paper industry, need, chemical applications. Biological applications to pulp and paper processing, bio-bleaching of pulps.

Books Recommended:

1. Pulping Process by Rydholm
2. Pulp & Paper Science and Technology, by C.E. Libby Vol I
3. Pulp and Paper Chemistry and Chemical Technology by J.P. Casey
4. Pulp and Paper Manufacture Vol-I, II and III by Macdonald
5. Hand book of Pulp and Paper technology by K.W. Britt.
6. Environment Friendly Technologies for pulp and Paper industry by Young R.A., Akhtar M.

BTCHT 505T/5 **Plastics& Polymer Technology III**
(Structure Property Relationship and Compounding of Polymers)

Unit 1: **Chemical composition and Molecular size and shape**
Chemical Composition of polymer molecule, Monomer ingredients in final polymer Molecular size and shape: Effect of molecular size on processing, mechanical, thermal, electrical optical and chemical properties.

Unit 2: **Intermolecular Order, Molecular Flexibility and Glass Transition temperature Intermolecular Order:** Amorphous and crystalline polymers. Factors determining crystallanity, effect of crystallanity on polymer properties.
Molecular Flexibility: Freedom of rotation, restriction of rotation.

Glass transition temperature: Glass transition temperature (Tg), Transition and associate properties, factors affecting Tg, significance of Tg

Unit 3: **Orientation and Intermolecular BondingOrientation:** Relations between orientation and crystallization, importance of mobility on orientation, axes of orientation, orientation during processing, effect of orientation on thermal, mechanical, thermal properties.

Intermolecular bonding: effect of polarity on polymer structure, effect of polarity on thermal, chemical, mechanical properties, cross linking and its effect on thermal, mechanical and chemical properties

Polymer Compounding

Unit 4: Polymer compound ingredients

Plasticizers & its mechanism, Lubricants and Flow Promoters , Anti-aging Additives(Antioxidants, Antiozonants, Stabilizers, Ultraviolet absorbers and related materials), processing aids, flame retardants, antistatic agents, nucleating agents, blowing agents , colorants, Cross-linking Agents etc.

Unit 5: Polymer compound ingredients

fillers and reinforcements viz. carbon black, ZnO, calcium carbonate,titanium oxide, nano clay, glass fibers, organic fillers, nanofillers.

Mixers: Batch and internal mixers, single screw extruder, kneaders, modular co-rotating and counter rotating twin screw extruders, Two roll mills, sigma mixer, co-kneader, cavity mixers, pin mixers, slotted fight mixers, variable depth mixers, planetary gear mixers, CRD mixers.

Unit 6: Rubber compounding Ingredient

Peptizers, role of peptizers, antioxidants- classification and examples, antiozonants, accelerators-classification according to cure rate, criteria for selection, mode of functioning, activators, methods of incorporation of reinforcements, chords and fabrics. Blowing agents, colorants, processing aids, tackifiers, softeners, extender oils.

Compounding formulations: Based on polyvinyl chloride, polyolefins, polystyrene, polyester, epoxy, compounding lines, post compounding operations.

Reference Books:

1. Introduction to Polymer Science and Technology, S. D. Dawande, Denett & Co., 2006.
2. Polymer Science, V.R Gowariker, New Age International Publishers, 2005.
3. Polymer Chemistry, C. E. Carrshar, Marcel Dakker Inc, 2003.
4. Plastic Materials, J A Brydson, Butterworth-Heinmann, 1999
5. Relating Materials, Properties to Structure; Handbook and Software for Polymer calculations and Materials Properties, D. J. David and Ashok Mishra, Technical Publishing Company, Inc, 1999.
6. Materials Properties to structure, D. J. David, Relating Technical Publishing Company Inc, 1999.
7. Text Book of Polymer Science, F.W.Billmeyer, Wiley International Publishers.1984.
8. Physical chemistry of Polymers, A. Tager, Mir Publishers, 1978.
9. Polymer Structure, Properties and application, R.D.Deanin, American Chemical Society, 1974.
10. Mixing and Compounding of Polymer Theory and Practice, 2nd Ed., I. M. Zloczwero, Hanser Publications, 2009.
11. Thermoplastic and Rubber Compounds Technology and Physical Chemistry, J.L. White, K. J. Kim, Hanser Gardner Publications Ltd., USA, 2007.
12. Polymer Mixing Technology and Engineering, J.L. White, A.L. Coran and A. Moet, Hanser Gardner Publications Ltd., USA, 2001.
13. Rubber Technology Compounding and Testing for Performance, Ed. J. S. Dick, Hanser Gardner Publications Ltd., USA, 2001.

14. Understanding Compounding, R. H. Wildi and C. Maier, HanserGardner Publications Ltd., USA, 1998.
15. Rubber Technology and Manufacturer, C.M.Blow, Butterworth, London, 1982.

BTCHT 505T/6 Surface Coating Technology III (Theory)
(Chemistry of Film forming Materials-II)

Unit 1: Epoxy resins, various types of reactions and resin characteristics. Curing agents and their chemistry. Epoxy esters, epoxy modified polyester epoxy, acrylates, epoxy phosphates, and epoxy amine adducts. Application of epoxy resins in coatings.

Unit 2: Cellulose derivatives in Surface Coatings, cellulose nitrate and types, nomenclature of different types of cellulose nitrates, cellulose acetate, ethyl and methyl cellulose. Preparation, manufacture and properties of cellulose nitrate, cellulose acetate, ethyl cellulose and methyl cellulose.

Unit 3: Natural and synthetic rubber. Occurrence, processing, properties and uses of natural rubber. Chemical composition of natural rubber latex. Modification of natural rubber. Preparation, properties and use of chlorinated rubber, cyclized and synthetics rubber and their properties. Application of rubber resins in coatings.

Unit 4: Vinyl and acrylic resins in surface coatings, composition, substituted ethylenes and copolymers, methods of polymerization and processes, polyvinyl chloride resins, vinyl chloride-vinyl acetate copolymers, cyclic ester resins, chemical composition and properties, methods of polymerization, acrylic ester resin emulsions. Polystyrene, polymethacrylate, polymethylmethacrylate, etc.

Unit 5: Silicone resins, structure of silicones, preparation of silicone polymers for surface coatings, ethyl silicates and titanium esters.

Unit 6: The Urethane reaction and uses of urathenes in surface coatings, Urethane Oils. Bituminous materials: Occurance, classification, properties and uses of bituminous materials. Bitumen, Asphalt, Gilsonite, Grahamite, Petroleum bitumen, Pitch, Coal tar pitch, Oil tar pitch, etc.

Books Recommended:

1. Organic Coating Technology by H F Payne, Vol I, John Wiley & Sons, New York, 1954
2. Paint Technology Manual Vols I, II and III, Oil, Colour Chemists Association
3. Text Book of Polymer Science by Billmeyer W, Interscience Publishers Inc., New York, 1962
4. An Introduction to Polymer Chemistry by Moore W R, Aldine Publishing Co, Chicago, US, 1963

Subject: BTCHT506P(BCHT) Fluid Flow Operation **(Practical)**

Practical : 3 Hours
University : 25 Marks
Duration of Examination: 6 Hours

No. of Credits : 2
College Assessment : 25 Marks

LIST OF EXPERIMENTS

Required to perform minimum 8 practical from the list given below:

1. Verification of Bernoulli's equation
2. To calibrate venturimeter and obtain its coefficient of discharge
3. To calibrate orificemeter and obtain its coefficient of discharge
4. To calibrate rotameter
5. To calibrate notched weir and obtain its coefficient of discharge
6. Friction factor vs. Reynolds number for flow of water in pipe
7. Friction factor vs. Reynolds number for flow of air in pipe
8. To study the relationship between fanning friction factor and Reynolds number for a fluid flowing though coils
9. To obtained equivalent length of pipe for various fitting.
10. Operating characteristics of centrifugal pump
11. To study the hydrodynamic characteristics of a packed bed
12. To study the hydrodynamic characteristics of a fluidized bed
13. Studies in two phase flow

Subject: BTCHT507P(BCHT) **Solid Fluid Operations (Practical)**

Practical : 3 Hours
University : 25 Marks
Duration of Examination: 6 Hours

No. of Credits : 2
College Assessment : 25 Marks

LIST OF EXPERIMENTS

Required to perform minimum 8 practical from the list given below:

1. To study the relationship between the Drag Coefficient and modified Reynolds number for body falling through fluid. (C_d vs N_{RE})
2. To carry out the batch Sedimentation test and to use the results to design a thickener.
3. To evaluate the Specific Surface of a packing material.
4. To establish the Filtration equation for the leaf filter system and to evaluate the compressibility of the cake.
5. To study the power consumption of an Agitator with Reynolds and Froud number.
6. To verify the laws of Crushing and Grinding.

7. To determine the Mean Arithmetic Diameter, Mean Surface Diameter and Mean Volume Diameter.
8. To determine the size distribution in a given sample. (Elutriation).
9. To determine the effectiveness of Vibrating Screen.
10. To separate the various size fractions in a mixture on the basis of their settling velocities in a fluid. (Size Separation).
11. To study the efficiency of a cyclone separator.

Subject: BTCHT508P (BCHT) **Chemical Equipment Design (Practical)**

Practical : 3 Hours No. of Credits : 2
University : 25 Marks College Assessment : 25 Marks
Duration of Examination: 6 Hours

LIST OF EXPERIMENTS

Minimum 8 sheets related to design and drawing mentioned below should be drawn. Out of 8, two drawing should be performed/demonstrated on AutoCAD.

1. Design of Pressure Vessels
2. Design of Vessel Supports
3. Design of Storage Tanks
4. Design of Heat Exchangers
5. Design of Tray Towers
6. Design of Packed Towers
7. Process Flow Symbols
8. Process Flow Diagram
9. Piping & Instrumentation Diagram
10. Equipment Layout
11. Use of AutoCAD

Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Engineering & Technology
Syllabus for
Sixth Semester B. Tech. Chemical Technology

Subject: BTCHT 601T (BCHT) **Process Engineering Thermodynamics (Theory)**
Lecture: 3 Hours No. of Credits: 4
Tutorial: 1 Hour University: 80 Marks
Duration of Examination: 3 Hours College Assessment: 20 Marks

Unit I: Basics of Thermodynamics

Review of laws of thermodynamics, Equations of state, Maxwell relationships, homogeneous phases, residual properties, heat effects, two-phase systems, Clausius- Clapeyron equation

Unit II: Compression of Fluid

Flow of compressible fluids, measurement of flow of compressible fluids, convergent-divergent nozzles, supersonic flow, Compression of fluids, single and multistage compression, centrifugal and reciprocating compressors-construction and working

Unit III: Refrigeration

Review of refrigeration cycles, Joule-Thomson expansion, compression and absorption refrigeration, refrigerants and their properties, estimation of power requirements of refrigeration systems, heat pumps.

Unit IV: Solution Thermodynamics

Fundamental property relations, chemical potential, criteria for phase equilibrium, partial properties, ideal gas mixtures, fugacity and fugacity coefficients for pure species, for species in solution, ideal solutions, Excess properties, VLE data-fugacity, Activity coefficients, Excess Gibb's energy, Margules and Van Laar equation, Property changes of mixing

Unit V: Phase Equilibria

Vapour – liquid equilibrium: The nature of equilibrium, criteria of equilibrium, phase rule, Duham's theorem, Raoult's law, VLE by modified Raoult's law, dew point and bubble point calculations, Flash calculations, Determine whether azeotrope exist**,** Equilibrium and stability, liquid -liquid equilibrium, solid-liquid equilibrium, VLL equilibrium

Unit VI: Chemical Reaction Equilibria

Criteria for equilibrium to chemical reactions, the standard Gibbs free energy change and the equilibrium constant. Effect of temperature on equilibrium constant, evaluation of the equilibrium constant, relation of equilibrium constant to composition, calculation of equilibrium conversion for single reaction, The phase rule and Duhem's theorem for reacting systems, multireaction Equilibria

Books Recommended:

1) J.M. Smith, H.C. Van Ness, M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 6th Edition, McGraw Hill, 2001.
2) K.V. Narayanan, Chemical Engineering Thermodynamics, Prentice-Hall India, 2006.
3) Y.V.C. Rao, Chemical Engineering Thermodynamics, Universities Press, 1997.
4) B.G. Kyle, Chemical & Process Thermodynamics, 3rd Edition, Prentice Hall, New Jersey, 1999.
5) O.A. Hougen, K.M. Watson, and R.A. Ragatz, Chemical Process Principles Part II, Thermodynamics, John Wiley, 1970.
6) R. Reid, J. Praunitz, T. Sherwood, The Properties of Gases and Liquids, 3rd Edition, McGraw-Hill, New York, 1977.

Subject: BTCHT 602T (BCHT) **Heat Transfer Operations (Theory)**

Lecture: 3 Hours
Tutorial: 1 Hour
Duration of Examination: 3 Hours

No. of Credits: 4
University: 80 Marks
College Assessment: 20 Marks

Unit I: Concept of Heat Transfer

Introduction & mechanism of heat transfer. Development and use of general differential equation for heat transfer rate & temperature distribution for steady state heat conduction for various shapes & geometries of solids with various boundary conditions, with & without heat generation.

Unit II: Unsteady State Heat Transfer, Fins & Insulation

Use of lumped capacitance, Heisler charts and error function methods for unsteady state heat transfer. Classification of fins. Fin efficiency and overall effectiveness. Classification and selection of various types of thermal insulations. The concept of critical and economical thickness of insulation and its evaluation for cylindrical and spherical heat transfer equipment.

Unit III: Natural & Forced Convection: Heat Transfer without Phase Change

Introduction to natural and forced convection in laminar and turbulent flow over flat plate, over cylinder & sphere and through closed channels. Concept and use of thermal & hydrodynamic boundary layer and its significance. Prediction of heat transfer coefficient using theoretical, empirical and analogies concepts.

Unit IV: Condensation & Boiling : Convection Heat Transfer with Phase Change

Mechanism of condensation: Nusselt's approach and its extension. Heat transfer in saturated pool & forced convection boiling of liquids. Study of Boiling curve : Its significance and relevance in constant wall temperature & constant heat flux boiling with specific reference to critical (Maximum) heat flux and minimum heat flux (Ladenfrost point).

Unit V: Heat Exchangers & Evaporators

Concept of fouling resistance & overall heat transfer coefficient in heat exchangers. Classification of heat exchangers. Design and rating of double pipe, shell and tube heat exchangers by LMTD and ε-NTU methods. Compact heat exchangers: Plate heat exchangers, helical coil heat exchangers, spiral heat exchangers, regenerators. Classification of evaporators. Steam economy and capacity of multiple effect evaporators. Design considerations of evaporators..

Unit VI: Radiation & Special Cases of Heat Transfer

Radiation fundamentals, properties of materials and heat exchange. Use of solar energy & thermic fluids. Heat transfer in furnaces, agitated vessels, fluidized beds, packed beds, jacketed vessels, immersed helical and spiral coil equipment.

Books Recommended:

1) B.K. Dutta, Heat transfer Principles and Applications, PHI Private Limited, 2001.
2) S.D. Dawande, Principles of Heat Transfer and Mass Transfer, Denett & Co, 2009.
3) R.K. Rajput, Heat and Mass Transfer, S. Chand & Company Ltd., 2007.
4) C.J. Geankoplis, Transport Processes and Separation Process Principles, 4 Edition, Prentice Hall, 2003
5) J.M. Coulson, J.F. Richardson with J.R. Backhurst, J.H. Harker, Chemical Engineering Vol. I: Fluid Flow, Heat Transfer and Mass Transfer, Sixth Edition, Butterworth-Heinemann an imprint of Elsevier
6) J.M. Coulson, J.F. Richardson with J.R. Backhurst, J.H. Harker, Chemical Engineering Vol. II: Particle Technology and Separation Processes, Fifth Edition, Butterworth-Heinemann an imprint of Elsevier
7) J. M. Coulson, J. F. Richardson, R. K. Sinnott, Chemical Engineering Vol. 6 - Design, Pergamon Press, 1983
8) W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill Publication, 2005.
9) D.S. Kumar, Basics of Heat & Mass Transfer, Eight Edition, S.K. Kataria & Sons, 2010.
10) W.L. Badger, J.T. Banchero, Introduction to Chemical Engineering, Tata McGraw Hill Education, 1997.

Subject: BTCHT 603T (BCHT) **Chemical Process Control (Theory)**

Lecture: 3 Hours
Tutorial: -----
Duration of Examination: 3 Hours

No. of Credits: 3
University: 80 Marks
College Assessment: 20 Marks

Unit 1: Laplace Transforms, forcing functions, transient response of the first and second order systems, time constants, damping coefficients, transfer functions for liquid level and mixing processes, linearization,

Unit 2: Response of first order system in series, transfer functions and transient response of interacting and non interacting systems, transportation lag,

Unit 3: Linear closed loop systems, chemical reactor control systems, block diagram, pneumatic and electronic controllers and final control elements, choice of controllers, stabilization time, characteristics of proportional, integral and derivative control modes, transient response of simple control systems, comparison of controllers,

Unit 4: Concept of stability of linear systems, Raouth Criteria, Root locus diagram for negative feed back systems,

Unit 5: Control system design by frequency response method, Bode stability criteria, gain and phase margins, Ziegler- Nichols controller settings,

Unit 6: Instrumentation diagrams of temperature control, level control, pressure control and composition control. Thermocouples and their characterization, measurement of temperature, level, pressure and composition

Text Books:

1)Process Systems Analysis and Control – Coughanowr and Koppel
2) Process Control and Instrumentation - R.P. Vyas

Reference Books:

1) Process Control - Peter Harriot
2) Automatic Process Control – D.P.Eckman
3) Industrial Instrumentation -D.P. Eckman

Subject: BTCHT 604T (BCHT)
Lecture: 3 Hours
Tutorial: 1 Hour
Duration of Examination: 3 Hours

Environmental Engineering (Theory)
No. of Credits: 4
University: 80 Marks
College Assessment: 20 Marks

Unit I: Environmental Pollutants

Sources & characterization of various pollutants. Concepts of biodegradability, biosorption, biomagnifications. Measurement : COD, BOD, TOD, ThOD, soluble, suspended, volatile solids, ammonical nitrogen. Mathematical model for BOD. Re-oxygenation and de-oxygenation in natural purification process.

Unit II: Natural Process of Water & Air Pollution Control

Mathematical analysis by Streeter-Phelps of oxygen sag curve in natural purification of waste water. Determination of stack height and plume rise. Meteorological parameters and their effects on dilution/dispersion of pollutants present in flue/exhaust gases coming out from stationery and moving sources. Prediction of pollutant concentration downstream of discharge point. Plume behavior.

Unit III: Air Pollution Management

Basic design and operating principles of wet & dry equipments for removal of particulate and gaseous pollutants. Control of air pollution by process changes.

Unit IV: Water Pollution Management

Principles of primary secondary, tertiary and advanced treatment of waste water. Aerobic and anaerobic processes in ponds and lagoons. Basic process design and operating principles of various activated sludge (suspended growth) processes. trickling filter & rotating biological contactor (Attached growth). Special reactors.

Unit V: Solid Waste Pollution Management:

Solid waste management by dumping, landfill, incineration, composting, vermiculture; using bioremediation for specific pollutants like chromium. Mercury, ammonia / urea, phenolic sludge. E-waste. Hazardous waste management.

Unit VI: Pollution Control in Selected Process Industries & Major Issues

Pollution in fertilizer industries, petroleum refineries and petrochemical units, pulp and paper industries, Sugar industries, Dairy, Alcohol industries. Radioactive wastes. Case studies. Environmental impact assessment (EIA),

Environmental audit, Major disasters, global environmental policies and national strategies.

Books Recommended:

1. Metcalf and Eddy, Wastewater Engineering: Treatment, Disposal and Reuse, Tata McGraw-Hill Pub.Co.Ltd., New Delhi, 1979.
2. S.P. Mahajan, Pollution Control in Process Industry, Tata McGraw Hill Publishers, 1987.
3. G.N. Pandey, G.C. Camey, Environmental Engineering, Tata McGraw-Hill Pub.Co.Ltd., 1992.
4. H.S. Peavy, D.R. Rowe, G. Tchobanoglous, Environmental Engineering, McGraw-Hill, 1986.
5. C.N. Sawyer, P.L. McCarty, G.F. Parkin, Chemistry for Environmental Engineering, Tata-McGraw-Hill Edition, 2003.
6. B.C. Punmia, A.K. Jain, A. K. Jain, Wastewater Engineering, Laxmi Publications, 2005.
7. S.K. Garg , Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 2010.
8. M.N. Rao, H.V. Rao, Air Pollution, McGraw-Hill Europe, 1989.

Subject: BTCHT 605T (BCHT)
Lecture: 3 Hours
Tutorial: 1 Hour
Duration of Examination: 3 Hours

Special Technology IV
No. of Credits: 4
University: 80 Marks
College Assessment: 20 Marks

BTCHT 605T/1 **Food Technology IV**
(Principles of Food Preservation)

Unit 1: **Food Spoilage :**
Food Spoilage Micro-organisms. Roles of Physical, Chemical and Microbiological factors in food spoilage. Intrinsic & Extrinsic factors affecting food spoilage. Food materials handling and process control. Primary, Secondary and Tertiary level of Food Processing. Basic principles and unit operation in food processing & preservation.

Unit 2: Preservation by application of heat – Cooking, Blanching, Pasteurization and Sterilization. Thermal Processing of Foods: Thermal conductivity of foods. Rate of heat penetration. Calculation of process time. Unit operations in canning. Irradiation – Effect of irradiation on food.Preservation by ionizing radiations, ultrasonics.

Unit 3: Dehydration – Role of water activity in food. Calculation of drying rate. Methods of dehydration. Drying equipments and potential applications. Drying effects on foods. Freeze drying. Evaporation – Principles of Evaporator operation. Boiling point estimation. Evaporator performance. Type of evaporators. Evaporation with feed preheating.

Unit 4: Freezing – Unit operations in freezing. Calculation of freezing time. Slow and fast freezing, cold storage, chilling of foods. Freezing equipments. Effect of freezing, frozen storage and thawing on the food quality. Storage & transportation of frozen foods. Freeze Concentration – Principles of freeze

concentration. Equipments used in freeze concentration. IQF. Application of freezing in food industry.

Unit 5: Membrane concentration – Driving forces for membrane processes. Types of membranes and equipments. Applications in food industry. Principles of high pressure technology and hurdle technology. Application of filtration techniques in food. Extraction processes- super critical extraction, solid liquid extraction, liquid-liquid extraction.

Unit 6: Packaging – Principles of packaging. Types and function of packaging, materials. Filling and sealing of containers like metallic, glass and plastic containers. Flexible packaging, laminated packaging and retortable pouches. Calculation of shelf life and requirement for packaging. Testing of packaging materials.

Books Recommended:

1. Principles of Food Science, Part II – Principles of Food Preservation. Edited by Owen R. Fennema. Printed in the United States of America.
2. Food Processing Technology – Principles and Practice by Dr. P. Fellow. Published jointly by Ellis Horwood Limited, Chichester, England and VCH Verlagsgesellschaft mbH, Weinheim Federal Republic of Germany.
3. Fundamental of Food Engineering by Charm SE. AVI Publishing Company Inc. Westport, Connecticur, USA.
4. Food Microbiology by W.C. Frazier. Tata Mc Graw Hill Publishing Co. Bombay.

Reference Books:

1. Food Processing Operation by M.A. Josyln and J.L. Heid. AVI publishing Company Inc. Westport, Connecticut, USA
2. Practical Canning by Lock A. Food Trade Press Garrick Street, W.C. 2, London.
3. Technology of Food Preservation by Desrosier Norman W. AVI Publishing Company Inc. Westport, Connecticut.
4. The Freezing Preservation of Foods, Vol. I, II, III, IV. Edited by Eople M.J. and Tressler D.K. AVI Publishing Company Inc. Westport, Connecticut, USA.
5. Food Dehydration, Vol. I, II by Copley. M.J. and Van Arsdel W.B. AVI Publishing Company Inc Westport,

BTCHT 605T/2 **Oil Technology IV (Theory)**
(Technology Of Soaps, Surfactants and Glycerin)

Unit 1: **Surfactants**

Concept and Theory of Surface action, structure of surfactant molecule, Hydrophilic – lipophilic balance, methods for measurement of surface activity. Mechanism of detergency, Uses in different fields. Classification of surfactants, Anionic, Cationic, Nonionic and Amphoteric surfactants, their classification, manufacture, evaluation and industrial applications

Unit 2: Detergents

Raw materials used in the manufacture of synthetic detergents and their functions. Manufacture and testing of household synthetic detergents, plants and processes employed for powders, liquids and cake detergents. Modern developments in the detergent industry. Recent trends and modern developments in the Detergent industry

Unit 3: Soap

Cleansing action of soaps, General principles of soap making , chemistry of soap boiling, Raw materials for soaps, their Classification and selection of oils and fat, role of INS factor, solubility ratio and hardness number, quality specifications and properties of oils and fats, Selection of builders and their functions, fillers and other auxiliary raw materials.

Unit 4: Plants and process employed in soap manufacture

Manufacture of household and toilet soaps by age old and newer techniques, details of machinery employed and quality specifications, , Continuous processes of soap manufacture. Modern process and plants for the production of house hold and toilet soaps from Fatty acid based soaps,

Unit 5: Analysis of soaps and detergents

BIS methods of testing, Properties of soaps and soap solutions, phase separation in soap boiling, various types of soaps andcleaning Preparations,

Unit 6: Technology of Glycerol

Sources, properties, grades, and types of glycerol, recovery and purification of glycerin from fat splitting crudes and waste soap lye's, analysis and industrial uses of glycerol. Synthetic glycerin

Reference Books:

1. The Handbook Of Soap Manufacture, Simmons ,W. H. and Appleton ,H. A. Kindle Books, USA.
2 .Soap, Detergent & Perfume Industry,Srivastava S.B ,Small Industry Research Institute,New Delhi.
3 .Sulphonation Technology In The Detergent Industry, Herman W. and De Groot, Springer-Verlag New York.
4. Surface Active Agents , Goliath Company,The Gale Group, USA
5. Powdered Detergents , Showell, M. The Procter & Gamble Company, Cincinnati, Ohio, USA.
6. Synthetic Detergents,. Davidson, A.,and Mılwidsky, B.M.,John Willey Sons,New York.
7.The manufacture of glycerol,by Martin, G. Technical Press, London
8. Handbook Of Detergents, Waldhoff, H.,and Henkel K.CRC Press, USA.
9. Soap-Chemistry and Technology, Kane,J. G.,
10. The Manufacture of Soaps, Other Detergents, and Glycerine,Woollatt, Edgar, Mountainview Books, PA, U.S.A.
11.Detergent Of Speciality Surfactants,Ed, Fredil,F.E.,Marcel Dekker, Inc.New York.
12. The Handbook of Soap Manufacture, by W. H. Simmons and H. A. Appleton,
13. Handbook of Detergents,Edited by Uri Zoller,CRC Press,London.

BTCHT 605T/3 Petroleum Refining and Petrochemical Technology IV
(Advanced Petroleum Refining)

Unit 1: COKING AND THERMAL PROCESSES

Types, Properties, and Uses of Petroleum Coke, Process Description & Operation -Delayed Coking Process Description—Flexi coking& Fluid Coking, Yields from Flexi coking and Fluid Coking, Capital Costs and Utilities for Flexi coking and Fluid Coking, Visbreaking, Case-Study Problem: Delayed Coker.

Unit 2: CATALYTIC CRACKING

Fluidized-Bed Catalytic Cracking , New Designs for Fluidized-Bed Catalytic Cracking Units, Cracking Reactions, Cracking of Paraffin's, Olefin Cracking, Cracking of Naphthenic Hydrocarbons, Aromatic Hydrocarbon Cracking, Cracking Catalysts, FCC Feed Pre-treating, Process Variables, Heat Recovery, Yield Estimation, Capital and Operating Costs, Case-Study Problem: Catalytic Cracker.

Unit 3: CATALYTIC HYDROCRACKING

Hydrocracking Reactions, Feed Preparation, The Hydrocracking Process, Hydrocracking Catalyst, Process Variables, Hydrocracking Yields, Investment and Operating Costs, Modes of Hydrocracker Operation , Case-Study Problem: Hydrocracker.

Unit 4: HYDROPROCESSING AND RESID PROCESSING

Composition of Vacuum Tower Bottoms, Processing Options, Hydroprocessing, Expanded-Bed Hydrocracking Processes, Moving-Bed Hydroprocessors, Solvent Extraction, Summary of Resid Processing Operations. Hydro treating**,** Hydro treating Catalysts, Aromatics Reduction, Reactions, Process Variables, Construction and Operating Costs, Case-Study Problem: Hydrotreaters. Supporting Processes**,** Hydrogen Production and Purification, Gas Processing Unit, Acid Gas Removal, Sulphur Recovery Processes etc.

Unit 5: CATALYTIC REFORMING AND ISOMERIZATION

Reactions, Feed Preparation, Catalytic Reforming Processes, Reforming Catalyst, Reactor Design, Yields and Costs, Isomerization, Capital and Operating Costs, Isomerization Yields, Case-Study Problem: Naphtha Hydrotreater, Catalytic Reformer, and Isomerization Unit.

Unit 6: ALKYLATION AND POLYMERIZATION

Alkylation Reactions, Process Variables, Alkylation Feedstock, Alkylation Products, Catalysts, Hydrofluoric Acid Processes, Sulphuric Acid Alkylation Processes, Comparison of Processes, Alkylation Yields and Costs, Polymerization, Case-Study Problem: Alkylation and Polymerization.

Books Recommended:

1.Petroleum Refining –Technology & Economics by J.H. Gary & G.E. Handwek
2.Petroleum Processing, Principles and Applications by R J Hengstebeck
3. Modern Petroleum Technology by G.D. Hobson

BTCHT 605T/4 **Pulp and Paper Technology IV**
(Pulping Processes IV)

Unit 1: Chemical Pulping, general considerations, various chemicals used, Alkaline pulping origin, alkali as delignification agent, Soda process, Sulfate or Kraft pulping process, flowsheet, description, unit operations and unit processes, composition of liquor, role of sodium oxide in alkaline pulping, standard kraft pulping terms.

Unit 2: Cyclic nature of Kraft pulping, variables associated with wood and pulping process, kinetics of Kraft process, batch and continuous digesters, direct and indirect cooking.

Unit 3: Blow tank operation, pulp washing, dilution factor, knotters, pulp screening and refining, and energy balance calculations of digester, blow tank and brownstock washers. Introduction to chemical recovery process, flow diagram, unit operations and unit processes.

Unit 4: Single and multiple effect evaporation, problems associated with the concentration of black liquor, optimization of steam pressure to evaporators, different feed arrangements, design considerations of multiple effect evaporators, cascade/ direct contact evaporators.

Unit 5: Combustion of black liquor, recovery furnace concept, composition of smelt, flue gases, salt cake reduction, heating value of black liquor solids, various heat losses during combustion, evaluation of thermal efficiency of a recovery furnace. Steam generation capacity. Characteristics and causticizing of green liquor, calcining of lime. Analysis of liquors.

Unit 6: Sulfite pulping, outline of the process, delignification, raw materials and technology, sulfur burning, sulfur dioxide absorption system, standard terms in the process, recovery of heat. Digesters, steam requirements, pulping variables, sodium, ammonium and magnesium based pulping recovery systems.

Books Recommended:

1. Pulping Process by Rydholm
2.Pulp and Paper Science and Technology by C.E.Libby Vol I
3.Pulp and Paper Chemistry and Chemical Technology by J.P. Casey
4.Pulp and Paper Manufacture Vol- I by MacDonald
5.Hand book of Pulp and Paper Technology by K.W. Britt.

BTCHT 605T/5 **Plastics & Polymer Technology IV**
(Elastomer Technology, Testing and Characterization)

Unit 1: **Natural Rubber**

Brief history of Natural Rubber (NR), Derivatives of NR, Preparation of NR-Taping, stabilization, coagulation, mastication.

Synthetic Rubber

Classification of Synthetic Rubber (SR) with reference to their applications. Structure, Synthesis, properties (raw and vulcanisate), curing systems, grades, trade names and application of general purpose synthetic rubbers like butyl rubber, SBR, BR, EPDM, NBR, CR, IR, Silicon rubber, Polysulphide Rubber.

Unit 2: **Vulcanization**

Introduction to vulcanizations & need for vulcanizations. Stress-strain relationships for vulcanized rubber, vulcanization by sulphur, peroxides and by other methods, types of vulcunisates, kinetics of vulcanization, chemical reactions, factors affecting rate of vulcanization.

Testing and properties

Determination of cure rate of rubbers, testing and analysis of raw rubber, ,testing of finished rubber products, permeability and cure adhesion, test methods for determination of free sulfur, ash content and total solid content, tear resistance, heat resistance, flex fatigue resistance, compression set, resilience, accelerated ageing, ozone resistance.

Unit 3: **Manufacturing and formulations**

Manufacturing and formulations of tyres, tubes, conveyor belts and flat belts, cellular products, hose technology, cables, footwear and latex goods, latex products such as dipped goods, foams, rubbers used in power transmission, O-rings, gaskets and seals.

Unit 4: **Mechanical Properties & Optical properties**

Mechanical Properties: Introduction, Tensile tests, Flexural properties, Compressive properties, Impact properties, Shear strength, Abrasion, Fatigue resistance, Hardness Tests.

Optical properties: Introduction, Refractive Index, Luminous Transmittance and Haze, Visual Color evaluation, Gloss.

Unit 5: **Thermal Properties, Electrical Properties & Chemical Properties**

ThermalProperties: Introduction, Tests for elevated temperature performance-Heat distortion temperature, Vicat softening temperature, Long term heat resistance test, Thermal conductivity, Thermal expansion, Brittleness temperature

Electrical Properties: Introduction, Dielectric strength, Dielectric constant and dissipation factor, Electrical resistance test, Arc resistance.

Chemical Properties: Immersion tests, Stain resistance test, Solvent stress cracking resistance, Environmental stress cracking resistance, Fluorescent UV Exposure of Plastics (ASTM D4329, ISO 4892-5)

Unit 6: Polymer Characterization

Basic fundamentals of FTIR, GPC, NMR, XRD, DSC and their applications in polymer characterization.

References:

1. Thermoplastic and Rubber Compounds Technology and Physical Chemistry, J.L. White, K. J. Kim, Hanser Gardner Publications Ltd., USA, 2007
2. Introduction to Polymer Science and Technology, S. D. Dawande, Denett & Co.,2006
3. Polymer Science, V.R Gowariker, New Age International Publishers, 2005
4. Rubber Technology Compounding and Testing for Performance, Ed. J. S. Dick, Hanser Gardner Publications Ltd., USA, 2001
5. Plastics Materials", J. A. Brydson, Jordon Hill, Oxford, 1999.
6. Polymer mixing technology", George Mathews , Applied science, London,1984
7. Rubber Technology and Manufacturer, C.M.Blow, Butterworth, London, 1982.
8. Physical chemistry of Polymers, A. Tager, Mir Publishers, 1978.
9. Handbook of plastics testing and failure analysis, Vishu Shah, Wiley International Publishers,2007
10. ASTM Manual 35,36,37
11. BIS and TST Manual

BTCHT 605T/6 Surface Coating Technology IV
(Chemistry and Technology of Pigments)

Unit 1: Pigments – Classification of pigments and extenders, composition of pigments, appearance, colour, hidin power, tinting strength, size and shape of pigments particules and its effect on the coating performance, oil absorptior specific gravity and bulking value, pigments flooding and floating.

Unit 2: General methods of manufacture of pigments, crushing and grinding, vapourisation, precipitation, roasting chemical reaction. Metal pigments and metallic pigments, aluminium powder and paste, bronze powders, lead powder and paste, metallic stearates.

Unit 3: Extenders, composition and properties, occurrence and manufacture of calcium carbonate extenders, calcium sulphate extenders, barium sulphate extenders, clay extenders.

Unit 4: White pigments, composition and comparison of properties, occurrence and manufacture of Titanium dioside, zinc oxide and sulphide, white lead, lithophone and antimony oxide. Black pigments, comparison of various black pigments and their composition, carbon black.

Unit 5: Coloured inorganic pigments, comparison of properties and their composition, methods of manufacture, natural earth colour, synthetic iron oxide pigments, chrome yellow and orange pigments, molybdate orange, zinc yellow pigments,

Venetian red, red lead pigments, cadmium coloured pigments, mercadium pigments, copper maroon pigments, ultramarine blue, iron blue pigments, chromium oxide green and hydrated chromium oxide.

Unit 6: Organic dyes and pigments, general characteristics, primaries and intermediates, colour in organic materials, chromophores, organic dyes and pigments containing nitro and nitroso groups, azo groups, anthraquinone, di and tri phenyl methane dyes, azines, phthalocyanine lakes and toners, manufacturing methods for commercial organic pigments.

Books Recommended:

1. Organic Coating Technology, Volume I, by H F Payne, John Wiley and Sons, New York, 1954
2. Organic Coating Technology, Volume II, by H F Payne, John Wiley, New York, 1954
3. Protective and Decorative Coatings, Vol II, by J J Matellio, John Wiley and Sons, New York
4. Protective and Decorative Coatings, Vol III by J J Matellio, John Wiley and Sons, New York
5. Paint Technology Manual

Subject : BTCHT 606P(BCHT) **Heat Transfer Operations(Practical)**
Practical : 3 Hours No. of Credits : 2
University : 25 Marks College Assessment : 25 Marks
Duration of Examination: 6 Hours

LIST OF EXPERIMENTS

Required to perform minimum 8 practical from the list given below:

1. To determine total thermal resistance and thermal conductivity of composite wall
2. To determine thermal conductivity of lagging material
3. To determine the air film heat transfer coefficient by natural convection using fin concept.
4. To determine the air film heat transfer coefficient by forced convection using fin concept.
5. To determine Stefan – Boltzman constant for radiation heat transfer
6. To determine convective heat transfer coefficient (while cooling and heating) from the transient response data, with the help of Heisler chart for an infinite cylinder
7. To determine convective heat transfer coefficient (while cooling and heating) from the transient response data, with the help of Heisler chart for Rectangular bar
8. Prediction of thermal conductivity of unknown material using Heisler chart
9. To determine the overall heat transfer coefficient for heating in jacketed enamelled kettle
10. To study boiling phenomenon in a jacketed kettle with and without stirring.
11. To determine overall heat transfer coefficient in shell and tube heat exchanger
12. To determine the overall heat transfer coefficient in CSTR

13. To study the heat transfer in plate type heat exchanger and calculate the overall heat transfer coefficient
14. To verify Dittus- Boelter equation for vertical tube exchanger
15. To determine and verify the relationship between overall heat transfer coefficient and velocity of fluid as suggested by Wilson
16. To determine heat transfer in fin and finless heat exchanger and evaluate fin effectiveness and fin efficiency
17. Verification of Nussult equation for filmwise condensation on the outer surface of inner tube in vertical concentric tube heat exchanger

Subject : BTCHT 607P(BCHT) **Environmental Engineering (Practical)**
Practical : 3 Hours No. of Credits : 2
University : 25 Marks College Assessment : 25 Marks
Duration of Examination: 6 Hours

LIST OF EXPERIMENTS

Required to perform minimum 8 practical from the list given below:

1. To determine the concentration of CO_2 present in waste water sample
2. Analysis of cation exchange effluents from thermal power plant (Determination of Ca^{2+} & $Mg^{2+)}$
3. To determine the alkalinity of a waste water sample by Warden method
4. Analysis of ferrous and ferric ions from pickling waste effluents
5. Determination of dissolved oxygen (DO) present in water sample
6. To determine the percentage of available chlorine present in bleaching powder
7. Determination of chemical oxygen demand (COD) present in waste water sample
8. Determination biological oxygen demand (BOD) present in waste water sample
9. Analysis of fly ash sample to determine the loss on ignition
10. Measurement of Air quality
11. Water softening using molecular sieves
12. Analysis and removal of TDS from waste water.
13. Removal of suspended particles from waste water.
14. Determination of Monod Kinetic constants
15. Determination of Specific Growth rate and maximum specific growth rate

Subject:BTCHT 608P (BCHT) **Special Technology II (Practical)**
Practical: 3 Hours No. of Credits: 2
University: 25 Marks College Assessment: 25 Marks
Duration of Examination: 4 Hours

BTCHT 608P/1 Food Technology Practical II

1. Estimation of reducing sugar by using 3,5 – dinitrosalicylic acid method
2. Estimation of protein by BIURET METHOD
3. Estimation of protein by Folin-Lowry method
4. Estimation of starch by Anthrone Method
5. Estimation of Amylose and Amylopectin content
6. Estimation of iron content
7. Estimation of phosphorus content
8. Preparation and sterilization of the media
9. Staining Techniques
10. Studying the effect of sugar concentration on yeast fermentation
11. Determination of number of microorganisms in a given milk sample by standard plate count method
12. Microbiological analysis of milk by Dye reduction method
13. Determination of adequacy of pasteurization of milk by phosphatase test
14. Determination of the turbidity of milk by sterility test.
15. Studying the effect of size of inoculums and temperature on the curdling of milk.

BTCHT 608P/2 Oil Technology Practical II

1. Beliers Test (Turbidity Temp.) Acetic Acid Method
2. Determination of Flash point
3. Detection of Colour by Tintometer Method
4. Estimation of RM and Polenske Value
5. Extraction of oil by Soxhlet Method
6. Extraction of essential oil by Clevenger's Assembly
7. Isolation and detection of Protein Content from deoiled cake
8. Estimation of Unsaponifiable Matter in oil
9. Preparation of Mixed Fatty Acids and its analysis
10. Preparation of Bio-diesel and its analysis
11. Preparation of Malenized oil and its analysis
12. Analysis of Mono and Diglycerides in oil and fats.

LIST OF REFERENCE BOOKS

1. Analysis of Oil and Soaps by R.N.Mathur
2. AOCS, official and tentative methods Da 2a-48, (For moisture and volatile matter of soap and soap products) 1973.
3. Bailey's Industrial Oil and Fat Products, 6th Edition, Wiley-Interscience Publication,New York .
4. The Analysis of Fats and Oils, Mehlenbacher, V. C., The Garrard Press, Champaign, Illinois.
5. AOCS Official and Tentative Methods forAnalysis ofOils and fats, Vol. 1and 2,, Third Edition, AOCS, Champaign IL,USA.

BTCHT 608P/3 Petroleum Refining and Petrochemical Technology II

1. Ash from Petroleum
2. ASTM distillation of Gasoline
3. ASTM distillation of Kerosine
4. ASTM distillation of Diesel fractions
5. Deemulsification number
6. Molecular Weight determination by Steam Distillation
7. Mercaptan sulphur content
8. Oxidation Stability Test
9. Penetration of Bitumen and Grease
10. Bromine Number by Color Indicator method
11. Bromine Number by Electrometric Titration method
12. Conradson Carbon Residue
13. Sulphonation
14. Water content by Dean and Start method
15. Viscosity Index
16. Electrical Strength of a Transformer Oil
17. Calorific value of fuel
18. Flue Gas Analysis by Orsat Analysis.
19. Total sulfur estimation by bomb method.

BTCHT 608P/4 Pulp & Paper Technology Practical II

Analysis of non fibrous materials used in Pulp and Paper Industry

1. Analysis of caustic soda as Na_2O

2. Analysis of Soda ash as Na_2O
3. Analysis of lime
4. Analysis of limestone
5. Analysis of Alum as combined and total Alumina
6. Analysis of rosin for acid no. and saponification no.
7. Analysis of Bleaching powder as available chlorine
8. Analysis of hypo solution
9. Analysis of Salt-cake as Na_2O
10. Analysis of filler and loading materials such as Calcium Carbonate, Clay, TiO_2
11. Preparation and analysis of White liquor, Black liquor, Green liquor
12. Analysis of waste water for COD, Suspended solids and dissolved solids

Books Recommended

TAPPI Standards, U S A

BTCHT 608P/5 Special Technology II (Practical)

(Plastics& Polymer Technology II)

1. Determination of specific gravity of polymers (Solid & liquid).
2. Identification of polymers by
    i. Preliminary Tests like Cut Test, Drop Test, Float Test
    ii. Heating Tests, Solubility Tests
    iii. Confirmatory tests of specific polymers
3. Measurement of viscosity average molecular weight of polymer.
4. To determine the plasticizer absorption percentage of PVC.
5. Determination of MFI of given polymer sample.
6. Determination of acid value, amine value & saponification value.
7. To study the Thermo Gravimetric Analysis (TGA).
8. To study the Thermal Transition of Plastic Materials via Differential Scanning Calorimeter (DSC).
9. To study Gel Permeation Chromatography for determination of molecular weight & MWD.
10. To study the FTIR Spectroscopy of Polymers.
11. To study the X-ray Diffraction technique & identification of % crystallinity via XRD.

BTCHT 608P/6 Surface Coating Technology II (Practical)
(Processing and modification of Resins)

1. Preparation and evaluation of Stand Oil.
2. Preparation and evaluation of Blown Oil.
3. Preparation and evaluation of Alkyd Resin by mono-glyceride process.
4. Preparation and evaluation of Alkyd Resin by fatty acid process.
5. Preparation and evaluation of Urea-formaldehyde resin.
6. Preparation and evaluation of Melamine formaldehyde resin.
7. Preparation and evaluation of Epoxy resin
8. Preparation and evaluation of Phenolic resin.
9. Preparation and evaluation of Polyamide/polyesteramide resins
10. Preparation and evaluation of Polyester resin.
11. Preparation and evaluation of Polyurethane resin
12. Preparation and evaluation of Urethane oils.
13. Preparation Acrylic resin by Bulk, Emulsion, Suspension, and Solution polymerization techniques.
14. Preparation and evaluation of Rosin ester/Ester gum.
15. Preparation and evaluation of short oil/long oil resin varnishes
16. Preparation and evaluation of Cellulose esters
17. Preparation and evaluation of synthetic rubber, chlorinated rubber, etc.

Subject:BTCHT 609P (BCHT)
Practical: 2 Hours
University: ---
Duration of Examination: 6 Hours

Minor Project
No. of Credits: 1
College Assessment: 50

The minor project will be for a group of three/four students under the guidance of departmental faculty of the institute and will carry 1 credit. The minor project will involve work based on analytical/experimental/design/industrial/combination of these topics in consultation with guide.
Each group of Students has to submit a typed and bound report (2 copies) at the end of the sixth semester to the respective guides. All students must go for minimum one relevant industry visit during the semester
Internal assessment marks will be awarded after the completion of the said project based on the work and presentation made by them in front of departmental committee.
Teaching load of minor project will be maximum 2 hours per week for each faculty.