# Dr. Babasaheb Ambedkar Technological University, Lonere

**(Established as a University of Technology in the State of Maharashtra)**

**(Under Maharashtra Act No. XXIX of 2014)**

**P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra**

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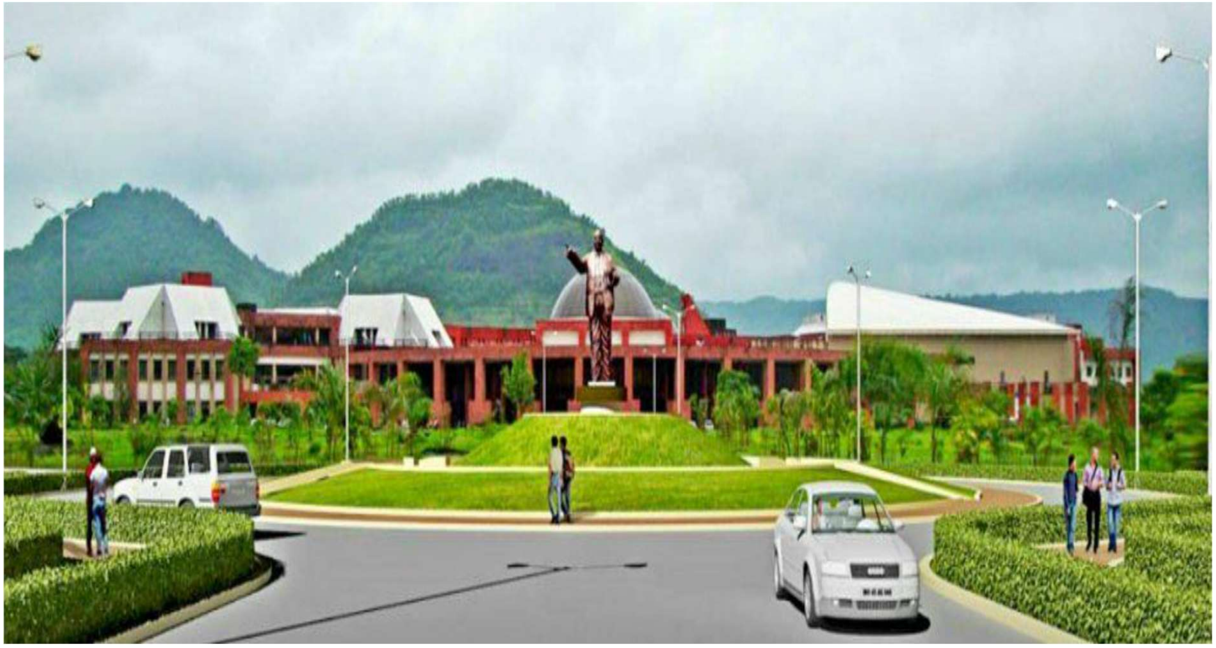
**www.dbatu.ac.in**

# Curriculum for Second Year

# Undergraduate Degree Programme

# B. Tech. in Petrochemical Engineering

## With effect from AY 2021-2022



**Dr. Babasaheb Ambedkar Technological University**

**Lonere 402 103, Dist- Raigad, Maharashtra, INDIA**

# Rules and Regulations

**EVALUATION SYSTEM:**

1. Absolute grading system based on absolute marks as indicated below will be implementeds from academic year 2019-20, starting from I year B.Tech.

| Perentage of Marks | Letter grade | Grade point |
|---|---|---|
| 91-100 | EX | 10.0 |
| 86-90 | AA | 9.0 |
| 81-85 | AB | 8.5 |
| 76-80 | BB | 8.0 |
| 71-75 | BC | 7.5 |
| 66-70 | CC | 7.0 |
| 61-65 | CD | 6.5 |
| 56-60 | DD | 6.0 |
| 51-55 | DE | 5.5 |
| 40-50 | EE | 5.0 |
| <40 | EF | 0.0 |

2. Class is awdared based on CGPA of all eigth semster of B.Tech Program.

| CGPA for pass is minimum 5.0 | |
|---|---|
| CGPAupto<5.50 | Pass class |
| CGPA $\geq$ 5.50 &<6.00 | SecondClass |
| CGPA $\geq$ 6.00 &<7.50 | First Class |
| CGPA $\geq$ 7.50 | Distinction |
| **[Percentage of Marks =CGPA*10.0]** | |

3. A total of 100 Marks for each theory course are distributed as follows:

| | | |
|---|---|---|
| 1. | Mid-Semester Exam (MSE) Marks | 20 |
| 2. | Continuous Assesment Marks | 20 |
| 3. | End Semester Examination (ESE) Marks | 60 |

4. A total of 100 Marks for each practical course are distributed as follows:

| | | |
|---|---|---|
| 1. | Continuous Assesment Marks | 60 |
| 2. | End Semester Examination (ESE)Marks | 40 |

**It is mandatory for every student of B.Tech. to score a minimum of 40 marks out of 100, with a minimum of 20 marks out of 60 marks in End Semester Examination for theory course.**

5. Description of Grades:

**EX Grade:** An ‘EX’ grade stands for outstanding achievement.
**EE Grade:** The ‘EE’ grade stands for minimum passing grade.

The students may appear for the remedial examination for the subjects he/she failed for the current semester of admission only and his/her performance will be awarded with EE grade only.

If any of the students remain absent for the regular examination due to genuine reason and the same will be verified and tested by the Dean (Academics) or committee constituted by the University Authority.

**FF Grade:** The 'FF' grade denotes very poor performance, i.e. failure in a course due to poor performance .The students who have been awarded 'FF' grade in a course in any semester must repeat the subject in next semester.

6. Evaluation of Performance:

1. Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

(A) Semester Grade Point Average (SGPA) The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPI is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{\left(\sum_{i=1}^{n} c_i g_i\right)}{\left(\sum_{i=1}^{n} c_i\right)}$$

Where
'n' is the number of subjects for the semester,
'ci' is the number of credits allotted to a particular subject, and
'gi' is the grade-points awarded to the student for the subject based on his performance as per the above table.
SGPA will be rounded off to the second place of decimal and recorded as such.

(B) Cumulative Grade Point Average (CGPA): An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since s/he entered the Institute. CGPA is also calculated at the end of every semester (up to two decimal places).Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{\left(\sum_{i=1}^{m} c_i g_i\right)}{\left(\sum_{i=1}^{m} c_i\right)}$$

where
'm' is the total number of subjects from the first semester onwards up to and including the semester S,
'ci' is the number of credits allotted to a particular subject, and

'gi' is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

CGPA will be rounded off to the second place of decimal and recorded as such.

**ATTENDANCE REQUIREMENTS:**

1. All students must attend every lecture, tutorial and practical classes.
2. To account for approved leave of absence (e.g. Representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted.
   If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination.
   The Dean (Academics)/ Principal is permitted to give 10% concession for the genuine reasons as such the case may be.
   In any case the student will not be permitted for appearing the examination if the attendance is less than 65%.
3. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.
4. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

**TRANSFER OF CREDITS**

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges/Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

a) 20 % of the total credit will be considered for respective calculations.
b) Credits transferred will be considered for overall credits requirements of the programme.
c) Credits transfer can be considered only for the course at same level i.e. UG, PG etc.
d) A student must provide all details (original or attested authentic copies) such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to Dean for approval.
e) A student has to get minimum passing grades/ marks for such courses for which the credits transfers are to be made.
f) Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.
g) In exceptional cases, the students may opt for higher credits than the prescribed.

**Dr. Babasaheb Ambedkar Technological Engineering**

Teaching and Evaluation Scheme for Second Year B. Tech. Petrochemical

| | Semester III | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Course Category** | **Course Code** | **Course Title** | **Teaching Scheme** | | | **Evaluation Scheme** | | | | |
| | | | L | T | P | CA | MSE | ESE | Total | Credit |
| BSC | BTBS301 | Engineering Mathematics – III | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PCC 1 | BTPCC302 | Unit Operations – I | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PCC 2 | BTPCC303 | Stoichiometry | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PCC 3 | BTPCC304 | Petrochemical Engineering –I | 4 | - | - | 20 | 20 | 60 | 100 | 4 |
| LC | BTPCL305 | Petrochemical Engineering Lab | - | - | 3 | 60 | - | 40 | 100 | 2 |
| LC | BTPCL306 | Unit Operations –I Lab | - | - | 3 | 60 | - | 40 | 100 | 2 |
| Seminar | BTPCS307 | Seminar I | - | - | 4 | 60 | - | 40 | 100 | 2 |
| Internship | BTPCI308 | Internship – 1 (Evaluation) | - | - | - | - | - | - | - | Audit |
| | | **Total** | **13** | **3** | **10** | **260** | **80** | **360** | **700** | **22** |
| | **Semester IV** | | | | | | | | | |
| PCC 4 | BTPCC401 | Chemical Engineering Thermodynamics | 4 | 1 | - | 20 | 20 | 60 | 100 | 5 |
| PCC 5 | BTPCC402 | Unit Operations – II | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| HSSMC | BTHM403 | Basic Human Rights | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| PCC 6 | BTPCC404 | Petrochemical Engineering – II | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PEC 1 | BTPCPE405 | Professional Elective –I | 4 | - | - | 20 | 20 | 60 | 100 | 3 |
| LC | BTPCL406 | Unit Operations -II Lab | - | - | 3 | 60 | - | 40 | 100 | 2 |
| Seminar | BTPCS407 | Seminar II | - | - | 4 | 60 | - | 40 | 100 | 2 |
| Internship | | Field Training / Internship 2/Industrial Training (minimum of 4 weeks which can be completed partially in third semester and fourth semester or in at one time). | - | - | - | - | - | - | - | Credit s To be evalua te d in V Sem. |
| | | **Total** | **16** | **2** | **7** | **260** | **100** | **380** | **700** | **23** |

** As per the recent directives from the University, online courses on Artificial Intelligence(credit course) and Constitution of India are added in third semester as mandatory courses over and above the courses mentioned in course structure.

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course, PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course, HSSMC = Humanities and Social Science including Management Course

Professional Elective – I

| Sr. No. | Course Code | Course Name |
|---|---|---|
| 01 | BTPCPE405 A | Environmentally Sustainable Technology |
| 02 | BTPCPE405 B | Fundamentals of Nanotechnology |
| 03 | BTPCPE405 C | Numerical Methods for Chemical Engineering |
| 04 | BTPCPE405 D | Introduction to Material Science |
| 05 | BTPCPE405 E | Advanced Engineering Chemistry |

# Semester III

## BTBS301 Engineering Mathematics – III 4 Credits

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| BSC | BTBS 301 | Engineering Mathematics-III | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Laplace and inverse Laplace transforms and their derivatives for elementary functions
2. properties of Laplace and inverse Laplace transforms to solve simultaneous linear and linear differential equations with constant coefficients
3. definitions and properties of Fourier transforms
4. solutions of partial differential equations governing real-world problems

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

| | |
|---|---|
| CO1 | Comprehend the fundamental knowledge of the Laplace and inverse Laplace transforms and their derivatives for elementary functions |
| CO2 | Apply the properties of Laplace and inverse Laplace transforms to solve simultaneous linear and linear differential equations with constant coefficients |
| CO3 | Conceptualize the definitions and properties of Fourier transforms, to solve boundary value problems using Fourier transforms |
| CO4 | Find the solutions of partial differential equations governing real-world problems |
| CO5 | Conceptualize limit, continuity, derivative and integration of complex functions, complex integrals useful in real-world problems |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | - | - | ✓ | | ✓ | - | - | - | - | - | - |
| CO2 | ✓ | - | - | ✓ | | ✓ | - | - | - | - | - | - |
| CO3 | ✓ | - | - | ✓ | | ✓ | - | - | - | - | - | - |
| CO4 | ✓ | - | - | ✓ | | ✓ | - | - | - | - | - | - |
| CO5 | ✓ | | | ✓ | | ✓ | | | | | | |

**Detailed syllabus:**

**Unit I**

**Laplace Transform :** Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by $t^n$, scale change property, transforms of functions divided by t, transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

**Unit II**

**Inverse Laplace Transform :** Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

**Unit III**

**Fourier Transform** : Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

**Unit IV**

**Partial Differential Equations and Their Applications** : Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation $\left(\text{i.e } \frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}\right)$, and one dimensional wave equation (i.e.$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$).

**Unit V**

**Functions of Complex Variables** : Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs).

**Text Books**


1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. RajnishVerma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.


**Reference Books**


1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill, New York.

## BTCHC302 Unit Operation - I 4 Credits

(Includes Mechanical and Fluid Flow Operations)

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| PCC | BTPCC302 | Unit Operation -I | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Manometers and decanters using the principles of fluid statics.
2. Pipe size / flow rate / power requirements under laminar / turbulent conditions
3. Motion of fluid, fluid – solid operations in packed and fluidized beds
4. Machinery for fluid transportation.
5. Mechanical operations and their role in chemical engineering
6. Nature of solids, their characterization, handling, and the processes involving solids.
7. Performance of size reduction equipment and calculate the power consumption.
8. Separation of solids based on size by different operations.

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

| | |
|---|---|
| CO1 | Derive dimensionless groups by dimensional analysis. |
| CO2 | Solve problems related to manometers and decanters using the principles of fluid statics. |
| CO3 | Determine the pipe size / flow rate / power requirements under laminar / turbulent conditions |
| CO4 | Solve problems involving motion of fluid, fluid – solid operations in packed and fluidized beds |
| CO5 | Select machinery for fluid transportation. |
| CO6 | Determine the flow rate of fluid passing through closed channels. |
| CO7 | Decide the usage of equipment for industrial application with respect to size reduction. |
| CO8 | Characterize particles and perform size reduction and size analysis of particles |
| CO9 | Evaluate the parameters of filtration |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO2 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO3 | √ | √ | √ | √ | √ | √ | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | √ | √ | - | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO6 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO7 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO8 | √ | √ | √ | √ | √ | √ | - | - | - | - | - | - |
| CO9 | √ | √ | √ | √ | √ | √ | - | - | - | - | - | - |

**Detailed syllabus:**

**Unit I**

Continuity equation for compressible and incompressible fluids. Bernoulli equation, Euler equation. Equation of motion.Types of flow, steady and unsteady, laminar and turbulent flows, relationship between shear stress and pressure gradient, Hagen Poiseuille equation. Prandtl mixing length theory and eddy diffusivity.

**Unit II**

Darcy-Weisbach equation for frictional head loss, friction factor, Moody diagram. Velocity profile and boundary layer calculations for turbulent flow. Flow through packed and fluidized beds. Pumps and compressors for handling different fluids, valves, pipe fittings and their standards, power requirement for flow, losses in pipes and fittings. Piping layout and economical pipe diameter.

**Unit III**

Flow measuring devices: orificemeter, venturimeter, rotameter, pitot tube, anemometer etc. Flow through constrictions such as notches, weirs, nozzles etc. mixing and agitation, calculation of power numbers and mixing indices. Liquid -liquid and liquid solid mixing. Vacuum producing devices.

**Unit IV**

Particle Characterization, Size Reduction, Sedimentation, Centrifugal Separation, Flocculation, Pneumatic and Hydraulic Conveying - Theory and Industrial Applications.

**Unit V**

Filtration: The Theory of Filtration. Filtration Practices, Filtration Equipments, Filtration in a Centrifuge and Filtration Calculations. Gas Cleaning Equipments, Size Enlargement.

**Texts / References:**


1. J. M. Coulson and J. F. Richardson, Chemical Engineering, Vol. 2, 4$^{th}$ ed. Pergamon Press
2. McCabe, J, C, Smith and P. Harriot, Unit Operations of Chemical Engineering, 4$^{th}$ ed. McGraw Hill, 1985
3. S. K. Gupta, Momentum Transfer Operations, Tata McGraw Hill, 1979.
4. A. S. Foust, L. A. Wenzel, C. W. Clump, L. B. Andersen, “Principles of Unit Operations”, 2$^{nd}$ ed. Wiley, New York, 1980.

# BTPCC303 Stoichiometry **4 Credits**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| PCC | BTPCC303 | Stoichiometry | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Material and energy balances of chemical processes.
2. Material and energy balances on chemical processes/equipment
3. Chemical Engineering problems involving recycle, purge and bypass
4. Ideal and real behavior of gases, vapors and liquids.
5.

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

| | |
|---|---|
| CO1 | Understand the material and energy balances of chemical processes. |
| CO2 | Perform material and energy balances on chemical processes/equipment |
| CO3 | Draw the flow diagram and solve the problems involving recycle, purge and bypass |
| CO4 | Understand the ideal and real behavior of gases, vapors and liquids. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | - | - | - | - | - |
| CO2 | √ | √ | √ | √ | √ | √ | √ | - | - | - | - | - |
| CO3 | √ | √ | √ | √ | √ | √ | √ | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | √ | √ | √ | - | - | - | - | - |

**Detailed syllabus:**

**Unit I**
Introduction to Chemical Engineering: Historical evolution of Chemical Engineering and Chemical Process Industries, Chemistry to Chemical Engineering, Revision of Units and Dimensions., Mathematical techniques, Introduction to use of calculators. Mole concept, composition relationships and stoichiometry

**Unit II**
Material Balances: Basic Material Balance Principles, Material balance problems without and with chemical reactions, Recycle, Bypass and Purge.

**Unit III**
Gases, Vapours and Liquids: Ideal Gas Law, Real Gas relationships, Vapour pressure, Vapor-Liquid Equilibrium calculations, Partial saturation & Humidity, Humidity chart, Material balances involving condensation and vaporization.

**Unit IV**
Energy Balances: Heat Capacity, Calculation of enthalpy changes, Energy balances without chemical reactions, Enthalpy changes of phase changes, Heat of solution and mixing, Energy balances accounting for chemical reactions - Standard heat of reaction, formation and combustion,

Hess Law, Effect of temperature, Adiabatic flame temperature.

**Unit V**
Un-steady state mass balances, with and without reactions.

**Texts / References:**

1. D.M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", 6th Edition, Prentice Hall of India, 1997.
2. B. I. Bhat and S. M. Vora, "Stoichiometry" Tata McGraw-Hill, New Delhi
3. V. Venkataramani, N. Anantharaman and K.M. MeeraSheriffa Begum, "Process Calculations" 2nd edition, Prentice Hall of India, 2015.

## BTPCC304 Petrochemical Engineering -I **4 Credits**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| PCC | BTPCC 304 | Petrochemical Engineering –I | 4 | - | - | 20 | 20 | 60 | 100 | 4 |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Indian Petroleum Refinery
2. Composition of crude oil
2. Quality of crude oil and petroleum products
3. Different operations in Refinery

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

| | |
|---|---|
| CO1 | Understand composition of crude oil |
| CO2 | Evaluate quality of crude oil and analyze product pattern |
| CO3 | Understand different operations in Refinery |
| CO4 | Evaluate and analyze quality of Petroleum Products |
| CO5 | Understand needs of Indian Petroleum Industry |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO2 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO3 | √ | √ | √ | - | - | - | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |

**Detailed syllabus:**

**Unit I**
Petroleum Geology and its scope, Origin of Petroleum (emphasis on both techniques and geochemistry), Composition of petroleum, Heteroatoms and metallic trace impurities, Oil and gas traps. Application of remote sensing in petroleum resource development, Basin and exploration strategies, Instruments used – principles and working; magnetometers, seismogram, radiation counters and gravimeters

**Unit II**
Drilling methods (vertical, deviated and horizontal), drilling fluids, plat form casting and cementation, geological formation testing, functions of geologist on drilling well, assessment of potential.

**Unit III**
Brief review of Petroleum, its formation and composition of crude oil, Characterization of crude oil, pretreatment of crude, removal of moisture, salts etc., general refinery set – up and function of various units, refinery flow diagram, equipment and tank yard layout.

**Unit IV**
Types of refineries such as simple, intermediate and complex, preflashing distillation principles, atmospheric distillation, column types, vacuum distillation, pressure distillation

**Unit V**
Major petroleum products and their specifications like LPG, Gasoline, Industrial solvents, naphtha, Kerosene, aviation turbine fuel (ATF), high speed diesel (HSD), LDO, furnace fuel, lubricants, base oil, tar and bitumen. Blending of various petroleum fractions to meet require specification, Gas to liquid processes. Methane, natural gas, CNG, rebuilding of hydrocarbons

**Texts /References:**
1. G. D. Hobson, Modern Petroleum Technology, Volume I
2. Lovetrsen, Geology of Petroleum
3. B. G. Deshpande, World of Petroleum
4. Hobson G.D., ‘Modern Petroleum Technology, Volume – II’ John Wiley & Sons 1986
5. Speight J.H., ‘The Chemistry and Technology of Petroleum Hydrocarbons’ Mercel Dekker, Inc, 1982

## BTPCL 305 Petrochemical Engineering Lab 2 Credits

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| LC | BTPCL 305 | Petrochemical Engineering Lab | - | - | 3 | 60 | - | 40 | 100 | 2 |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Different tests for petroleum and their significance
2. Quality of products
3. Performance of products in Real life
4. Identification of adulteration of products
5. Different industrial parameters of Refinery

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

| | |
|---|---|
| CO1 | Perform different Tests and Understand their Significance |
| CO2 | Evaluate quality of products |
| CO3 | Understand scientific principles involved in a test |
| CO4 | Understand and predict performance of Product in Real life |
| CO5 | Analyze and identify adulteration of products |
| CO6 | Setup different industrial parameters of Refinery |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | √ | - | - | - | √ | - | - | - | - | - | - |
| CO2 | - | √ | - | - | - | √ | - | - | - | - | - | - |
| CO3 | √ | √ | √ | - | - | - | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO5 | - | √ | - | - | - | - | - | - | - | - | - | - |
| CO6 | - | √ | - | - | - | - | - | - | - | - | - | - |

**List of Experiments:**

1 . To determine the Density, Specific gravity and API gravity of given petroleum and petroleum fraction.
2. To determine cloud point and of pour point given petroleum and petroleum fraction.
3. To determine the flash point and fire point of given petroleum fraction.
4 . To determine the Reid Vapor Pressure of given petroleum product
5. To determine the aniline point of given petroleum fraction
6. To determine the carbon residue of given petroleum fraction by Ramsbottom Method.
7. To determine the carbon residue of given petroleum fraction by Conradson Method.
8. Detection of copper strip corrosion by petroleum product using copper strip tarnish test.
9. To determine the smoke point of given petroleum product.
10. To determine the viscosity of given petroleum product by different viscometers
11. To determine the penetration index of given grease sample.
12. To Determine the vaporization characteristics of given petroleum product (Gasoline) by

ASTM –D 086 distillation.

13. To Determine the vaporization characteristics of given petroleum product (Diesel) by ASTM –D086 distillation.

## BTPCL 306 Unit Operations - I Lab **2 Credits**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| **LC** | **BTPCL 306** | **Unit Operations - I Lab** | **-** | **-** | **3** | **60** | **-** | **40** | **100** | **2** |

**(**Perform minimum 9 and maximum 11 of the experiments from the two sets, *viz.* Fluid Flow and mechanical Operations with at least 4 experiments from each set. This list is indicative. Colleges and departments can choose additional experiments as per availability subject to adherence with the syllabus.)

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Viscosity determination using Fenske or other viscometer
2. Laminar and turbulent flows.
3. Selection of manometric fluid for experiment.
4. Characteristics of packed & fluidized beds and centrifugal pumps
5. Ball, gate, globe, check valves, elbow, bend and T-joint
6. Screen effectiveness
7. Dry and wet screen analysis
8. Cyclone separator and froth flotation

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

| | |
|---|---|
| CO1 | Determine viscosity using Fenske or other viscometer and terminal velocity |
| CO2 | Distinguish laminar and turbulent flows. |
| CO3 | Select manometric fluid for experiment. |
| CO4 | Determine the characteristics of packed & fluidized beds and centrifugal pumps |
| CO5 | Identify ball, gate, globe, check valves, elbow, bend and T-joint |
| CO6 | Understand screen effectiveness |
| CO7 | Understand dry screen analysis |
| CO8 | Understand wet screen analysis |
| CO9 | Understand cyclone separator and froth flotation |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO2 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO3 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | √ | - | - | - | - | - | - | - |

**List of Experiments (Fluid Flow Operations):**
1. Determination of flow regimes -Reynolds' apparatus
2. Verification of Bernoulli's equation
3. Determination of Fanning friction factor for smooth and rough pipes
4. Determination of equivalent length of pipe fittings
5. Determination of viscosity with capillary tube viscometer.
6. Determination of friction factor for flow through packed bed.
7. Determination of discharge coefficient for venturi meter
8. Centrifugal pump characteristics
9. Study of Rota meter

**List of Experiments (Mechanical Operations):**
1. Determination of screen effectiveness
2. Dry screen analysis
3. Wet screen analysis
4. Study of sedimentation
5. Study of air elutriation
6. Study of cyclone separator
7. Study of froth flotation

## BTPCS307 Seminar I **2 Credits**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| Seminar | BTPCS307 | Seminar – I | - | - | 4 | 60 | - | 40 | 100 | 2 |

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

| | |
|---|---|
| CO1 | Acquire knowledge on topics outside the scope of curriculum. |
| CO2 | Communicate with group of people on different topic |
| CO3 | Collect and consolidate required information on a topic |
| CO4 | Prepare a seminar report and present |

Each student is expected to collect information on recent advances in Chemical Engineering by regularly referring to national and international journals and reference books. At the end of the semester he/she is required prepare a report as per the guide lines prescribed by the Department. Each student will be assigned a guide for this seminar course. Every student shall give a power point presentation on his Seminar topic before a panel of examiners.

# BTPCI 308 Internship - 1 (Evaluation)

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| Internship | BTPCI308 | Internship - 1 (Evaluation) | - | - | - | - | - | - | - | Audit |

**BTPCI 308 Internship – I (Industrial Training)**

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

| | |
|---|---|
| CO1 | Acquire knowledge on topics outside the scope of curriculum |
| CO2 | Communicate with group of people on different topics. |
| CO3 | Collect and consolidate required information on a topic. |
| CO4 | Prepare the report and present |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | - | - | - | - | - | √ |
| CO2 | √ | √ | - | - | √ | √ | - | - | √ | √ | √ | √ |
| CO3 | - | √ | - | - | √ | - | √ | - | - | - | √ | √ |
| CO4 | - | - | - | - | - | - | - | - | √ | - | √ | √ |

Each student is expected to spend Four weeks in any one factory/project/workshop at the end of semester II (during summer vacation). Here he/she shall observe layout, working and use of various machinery, plants, design, instruments, process etc. under the general supervision of the foreman/artisan/engineer of the factory etc.

The student shall submit the report in a systematic technical format about the major field of the factory, particularly about the section/department where he/she has received the training giving details of equipment, machinery, materials, process etc. with their detailed specifications, use etc. The report shall be checked and evaluated by the concerned teacher and appropriate grade shall be awarded.

# Semester IV

## BTPCC401 Chemical Engineering Thermodynamics 5 Credits

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| PCC | BTPCC401 | Engineering Thermodynamics | 4 | 1 | - | 20 | 20 | 60 | 100 | 5 |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. First and second laws of thermodynamics to chemical processes and the properties of ideal and real mixtures.
2. Behavior of flow and non-flow processes using mass and energy balances
3. Heat and work requirements for industrial processes.
4. Efficiency of processes involving heat into work, refrigeration and liquefaction
5. Heat effects involved in industrial chemical processes
6. Thermodynamic properties of gaseous mixtures / solutions
7. Bubble-P & T, Dew-P & T for binary and multi-component systems
8. Vapor-liquid equilibrium (VLE) composition for ideal and non-ideal systems
9. Equilibrium constant and composition of product mixture at given temperature and pressure.

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

| | |
|---|---|
| CO1 | Apply the first and second laws of thermodynamics to chemical processes. |
| CO2 | Compute the properties of ideal and real mixtures. |
| CO3 | Analyze the behavior of flow and non-flow processes using mass and energy balances |
| CO4 | Estimate heat and work requirements for industrial processes. |
| CO5 | Determine the efficiency of processes involving heat into work, refrigeration and liquefaction |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | - | √ | - | - | - | - | - | - |
| CO2 | √ | √ | √ | √ | - | - | √ | - | - | - | - | - |
| CO3 | √ | √ | √ | √ | - | √ | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | - | √ | √ | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | - | - | √ | - | - | - | - | - |

**Detailed syllabus:**

**Unit I**

**Introduction :** The Scope of thermodynamics; Dimensions and units; Measures of Amount or size; Force; Temperature; Pressure; Work; Energy; Heat.

**The First Law of Thermodynamics:** Joule's Experiments; Internal Energy; The First Law of Thermodynamics; Energy balance for closed systems; Thermodynamic state and state functions; Equilibrium; The phase rule; The reversible process; Constant V and constant P processes; Enthalpy; Heat capacity; Mass and energy balances for open systems.

**Volumetric Properties of Pure Fluids :** PVT Behavior of pure substances; the Virial Equation; The Ideal Gas; Application of the Virial Equation; Cubic Equations of State; Generalized Correlation's for gases; Generalized correlation's for Liquids**.**
**Heat Effects:** Sensible Heat Effects, Heat Effects Accompanying Phase Changes of Pure Substances,

**Unit II**
**The Second Law of Thermodynamics :** Statement of the Second law : The Heat Engine; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the Second Law; Entropy balance for open systems; Calculation of ideal work; Lost work; The Third Law of Thermodynamics; Entropy from the Microscopic view point. **Thermodynamic Properties of Fluids:** Property Relations for Homogeneous phase; Residual Properties; Residual properties by equations of state; Two phase systems, Thermodynamic diagrams; Tables of Thermodynamic properties; Generalized property correlations for gases.

**Unit III**
**Applications of Thermodynamics to Flow Processes:** Duct flow of compressible fluids; Turbines (expanders); Compression processes.
**Refrigeration And Liquefaction :** The Carnot Refrigerator; the vapour-compression cycle; The Choice of refrigerant; Absorption Refrigeration; The heat pump; Liquefaction Processes. **Vapour/Liquid Equilibrium Introduction**: The nature of equilibrium, the Phase Rule, Duhem's Theorem, VLE: Qualitative behaviour, Simple models for vapour/liquid equilibrium, VLE by modified Raoult's Law, VLE from K- value correlations.

**Unit IV**
**Solution Thermodynamics: Theory:** Fundamental property relation, The chemical potential and phase equilibria, Partial properties, Ideal gas mixtures, Fugacity and fugacity coefficient. Fugacity and fugacity coefficient: Species in the solution, generalized correlations for the fugacity coefficient, the ideal solution, Excess properties.
**Solution Thermodynamics: Applications:** Liquid-phase properties from VLE data, Models for the excess Gibbs energy, Property changes of mixing, Heat Effects of mixing processes.

**Unit V**
**Chemical Reaction Equilibria:** The reaction coordinate, Application of equilibrium criteria to chemical reactions, The standard Gibbs energy change and equilibrium constant, Effect of temperature on the equilibrium constants. Relation of equilibrium constants to composition, Equilibrium conversions for single reactions, Phase rule and Duhem's theorem for reacting systems, Multi reaction equilibria.

**Texts/References:**

1. J. M. Smith, H.C. Van Ness, and M.M. Abbott, Chemical Engineering Thermodynamics, $6^{th}$ed, Tata McGraw Hill edition, 2003.
2. Y. V. C. Rao, "Chemical Engineering Thermodynamics", University Press 1997
3. S. I. Sandler. "Chemical Engineering Thermodynamics", Wiley, New York, 1999.

# BTPCC 402 Unit Operations -II **4 Credits**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| PCC | BTPCC402 | Unit Operations –II | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Different modes of heat transfer.
2. Heat transfer coefficients for forced and natural convection.
3. Heat transfer involving phase change.
4. Heat exchanger performance for co-current and counter-current flows.
5. Double pipe and shell & tube heat exchangers.

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

| | |
|---|---|
| CO1 | Understand the modes of heat transfer. |
| CO2 | Determine heat transfer coefficients for forced and natural convection. |
| CO3 | Understand heat transfer involving phase change. |
| CO4 | Analyze the heat exchanger performance for co-current and counter-current flows. |
| CO5 | Design double pipe and shell & tube heat exchangers |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | - | - | - | - | - |
| CO2 | √ | √ | √ | √ | - | - | √ | - | - | - | - | - |
| CO3 | √ | √ | √ | √ | - | √ | √ | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | - | √ | √ | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |

**Detailed syllabus:**

**Unit I**

**Conduction:** Conduction through a single homogeneous solid, thermal conductivity of solids, liquids and gases. Conduction through several bodies in series. Contact resistances. Unsteady state heat conduction, lumped heat capacity system, transient heat flow in a semi-infinite solid.

**Heat transfer by Convection**: Forced convection, Laminar heat transfer on a flat plate Laminar and turbulent flow heat transfer inside and outside tubes. Film and overall heat transfer coefficients. Resistance concept, Coefficients for scale deposits, L.M.T.D. in heat exchangers with co and counter current flow. Heat exchanger design, Effectiveness – N T U method in finned tube heat exchangers.

**Unit II**

**Natural convection**: Heat transfer from plates and cylinders in verticals and horizontal configuration, natural convection to spheres. Heat transfer with phase change, i. e. heat transfer in Boiling and condensation, Single and multiple effect evaporators.

**Heat Transfer by Radiation:** Black and gray body radiations, view factor, luminous and non-luminous gases. Combined heat transfer, i.e. conduction, convection and radiation together. Concept of critical insulation thickness.

**Unit III**

**Combined natural and forced convection:** Fluid flow and heat transfer across cylinders and spheres. Combined natural and forced convection heat transfer in horizontal circular conduits. Heat transfer in extended surfaces such as fins, conduction convection heat transfer, forced convection heat transfer in circular conduits with longitudinal fins. Heat transfer in non Newtonian fluids.

**Unit IV**

**Introductory Concepts of Heat exchanger design:** Design of single and multi pass shell and tube type exchangers using LMTD and effectiveness – NTU methods. Spiral coil and plate type heat exchangers. Single and multi phase condenser. Design of Reboilers, vapourisers, Kettle type and Thermosiphon reboilers, forced circulation vaporizers. Heat transfer in agitated vessels both, jacketed and with coil, Determination of overall heat transfer coefficient, transient heating or cooling. Heat transfer in packed and fluidized beds.

**Unit V**

Heating of crude oil through exchangers. Pipestill heaters, their types and constructional features, estimation of heat duty, combustion calculation and heat transfer area in different parts in pipe still heater. Calculation of pressure drop and stack height.

**Texts / References:**


1. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 1 ELBS, Pergamon press, 1970
2. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergamon press, 1970
3. W. L. McCabe J. C. Smith and P. Harriot, "Unit Operations of Chemical Engineering", $4^{th}$ ed. McGraw Hill 1985.
4. D. Q. Kern, "Process Heat Transfer", McGraw Hill, 1950.

# BTHM403 Basic human rights **3 Credits**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| HSSMC | BTHM403 | Basic human rights | 3 | - | - | 20 | 20 | 60 | 100 | 3 |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Train the young minds facing the challenges of the pluralistic society and the rising conflicts and tensions in the name of particularistic loyalties to caste, religion, region and culture.
2. Give knowledge of the major "signposts" in the historical development of human rights, the range of contemporary declarations, conventions, and covenants.
3. Enable them to understand the basic concepts of human rights (including also discrimination, equality, etc.), the relationship between individual, group, and national rights.
4. Develop sympathy in their minds for those who are denied rights.
5. Make the students aware of their rights as well as duties to the nation.

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

| | |
|---|---|
| CO1 | Students will be able to understand the history of human rights. |
| CO2 | Students will learn to respect others caste, religion, region and culture. |
| CO3 | Students will be aware of their rights as Indian citizen. |
| CO4 | Students will be able to understand the importance of groups and communities in the society. |
| CO5 | Students will be able to realize the philosophical and cultural basis and historical perspectives of human rights. |

**Detailed syllabus:**

**Unit I**
The Basic Concepts: - Individual, group, civil society, state, equality, justice.
Human Values, Human rights and Human Duties: - Origin, Contribution of American bill of rights, French revolution. Declaration of independence, Rights of citizen, Rights of working and exploited people

**Unit II**
Fundamental rights and economic programme.
Society, religion, culture, and their inter-relationship. Impact of social structure on human behavior, Social Structure and Social Problems: - Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labor.

**Unit III**
Migrant workers and human rights violations, human rights of mentally and physically challenged.
State, Individual liberty, Freedom and democracy.
NGOs and human rights in India: - Land, Water, Forest issues.

**Unit IV**

Human rights in Indian constitution and law:-
i) The constitution of India: Preamble
ii) Fundamental rights.
iii) Directive principles of state policy.
iv) Fundamental duties.
v) Some other provisions.

**Unit V**
Universal declaration of human rights and provisions of India. Constitution and law. National human rights commission and state human rights commission.

**Reference books:**


1. Shastry, T. S. N., India and Human rights: Reflections, Concept Publishing Company India (P Ltd.), 2005
2. Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives(Law in India), Oxford India


# BTPCC 404 Petrochemical Engineering -II **4 Credits**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| **PCC** | **BTPCC 404** | **Petrochemical Engineering -II** | **3** | **1** | **-** | **20** | **20** | **60** | **100** | **4** |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Types of pipe still heaters and heat duty calculations
2. Equilibrium of multicomponent systems
3. Design distillation column for multicomponent system
4. Different types of distillation column

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

| | |
|---|---|
| CO1 | Understand working types and calculate heat duty for pipe still heaters |
| CO2 | Understand the equilibrium of multicomponent systems |
| CO3 | Design distillation column for multicomponent system |
| CO4 | Understand different types of distillation column and to do inter-conversion of data |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO2 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO3 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |

**Detailed syllabus:**

**Unit I**
Flash distillation, Dew point and Bubble point calculations, temperature and concentration profile in a distillation column.

**Unit II**
Multicomponent distillation, Calculation of number of stages in distillation, Key component concept, Comparison between multicomponent distillation and petroleum distillation

**Unit III**
Distillation curves and their interconversion at atmospheric, sub atmospheric and super atmospheric pressure, Collection and data for distillation column design and operation etc.

**Unit IV**
Atmospheric distillation, principles and mode of excess heat removal, Flash zone calculation and estimation of side draw tray temperatures, Design aspects, Post treatment of straight run products.

**Unit V**
Vacuum distillation column internals and operational aspects for lubes, asphalt, cracking feedstock, Pressure distillation and gas fractionation units, Difference between various types distillation regaining products of pressure distillation.

**Texts / References:**

1. B.K.Bhaskar Rao , Modern Petroleum Refining Processes , Oxford & IBH (2006)
2. W.L. Nelson, Petroleum Refinery Engineering, McGraw –Hill, 1964
3 M. Vanwinkle , Distillation , McGraw –Hill ,1961

# BTPCE405 Professional Elective – I 3 Credits

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| PEC | BTCHE405 | Professional Elective – II | 3 | - | - | 20 | 20 | 60 | 100 | 3 |

**A. Environmentally Sustainable Technology**

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Principles and concepts of green chemistry
2. Processes to reduce waste production and energy consumption
3. Technologies to reduce the level of emissions from buildings and core infrastructure
4. New environmentally sustainable technologies
5. Effects of pollutants on the environment

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

| | |
|---|---|
| CO1 | Understand principles and concepts of green chemistry |
| CO2 | Understand and Evaluate the process to reduce waste production and energy consumption |
| CO3 | Measure and Compare performance of different processes |
| CO4 | Understand new environmentally sustainable technologies |
| CO5 | Effects of pollutants on the environment |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO2 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO3 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | - | √ | - | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |

**Detailed syllabus:**

**Unit I**

**Principles and concepts of Green Chemistry:** Introduction, Sustainable Development and Green Chemistry, Atom Economy, Atom Economic Reactions, Rearrangement Reactions, Addition Reactions, Atom Un-economic Reactions, Substitution Reactions, Elimination Reactions, Wittig Reactions, Reducing Toxicity, Measuring Toxicity.

**Unit II**

**Waste Production, Problems and Prevention:** Introduction, Some Problems Caused by Waste, Sources of Waste from the Chemical Industry, The Cost of Waste, Waste Minimization Techniques, The Team Approach to Waste Minimization, Process Design for Waste Minimization, Minimizing Waste from Existing Processes, On-site Waste Treatment, Physical Treatment, Chemical Treatment, Bio treatment Plants, Design for Degradation, Degradation and Surfactants, DDT, Polymers, Some Rules for Degradation, Polymer Recycling, Separation and Sorting, Incineration, Mechanical Recycling, Chemical Recycling to Monomers.

**Unit III**

**Measuring and controlling environmental performance:** The Importance of Measurement, Lactic Acid Production, Safer Gasoline, Introduction to Life Cycle Assessment, Green Process Metrics, Environmental Management Systems, The European Eco-management and Audit Scheme, Eco-labels, Legislation, Integrated Pollution Prevention and Control.

**Catalysis and green chemistry:** Introduction to Catalysis, Comparison of Catalyst Types, Heterogeneous Catalysts, Basics of Heterogeneous Catalysis, Zeolites and the Bulk Chemical Industry, Heterogeneous Catalysis in the Fine Chemical and Pharmaceutical Industries, Catalytic Converters, Homogeneous Catalysis, Transition Metal Catalysts with Phosphine Ligands, Greener Lewis Acids, Asymmetric Catalysis, Phase Transfer Catalysis, Hazard Reduction, C–C Bond Formation, Oxidation Using Hydrogen Peroxide, Biocatalysis, Photo catalysis.

**Unit IV**

**Organic solvents, Environmentally benign solutions:** Organic Solvents and Volatile Organic Compounds, Solvent-free Systems, Supercritical Fluids, Supercritical Carbon Dioxide, Supercritical Water, Water as a Reaction Solvent, Water-based Coatings, Ionic Liquids, Ionic Liquids as Catalysts, Ionic Liquids as Solvents, Fluorous Biphase Solvents.

**Renewable resources:** Biomass as a Renewable Resource, Energy, Fossil Fuels, Energy from Biomass, Solar Power, Other Forms of Renewable Energy, Fuel Cells, Chemicals from Renewable Feedstock, Chemicals from Fatty Acids, Polymers from Renewable Resources, Some Other Chemicals from Natural Resources, Alternative Economies, The Syngas Economy, The Bio refinery, Chemicals from renewable feed stocks.

**Unit V**

**Emerging Greener technologies and Alternative energy solutions:** Design for Energy Efficiency, Photochemical Reactions, Advantages of and Challenges Faced by Photochemical, Processes, Examples of Photochemical Reactions, Chemistry Using Microwaves, Microwave Heating, Microwave-assisted Reactions, Sonochemistry and Green Chemistry, Electrochemical Synthesis, Examples of Electrochemical Synthesis.

**Designing greener processes:** Conventional Reactors, Batch Reactors, Continuous Reactors, Inherently Safer Design, Minimization, Simplification, Substitution, Moderation, Limitation, Process Intensification, Some PI Equipment, Examples of Intensified Processes, In-process Monitoring, Near-infrared Spectroscopy.

**An integrated approach to a greener chemical industry:** Society and Sustainability, Barriers and Drivers, The Role of Legislation, EU White Paper on Chemicals Policy, Green Chemical Supply Strategies.

**Texts / References:**

1. Mike Lancaster, Green Chemistry, Royal Society of Chemistry, 2010.
2. Paul T. Anastas John C. Warner, Green Chemistry: Theory and Practice, Oxford University Press, 2000.
3. Jay Warmke, Annie Warmke, Green Technology, Educational Technologies Group, 2009.

**B. Fundamentals of Nanotechnology**

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Properties of nano-materials and their applications
2. Chemical engineering principles to nano-particles production and scale-up
3. Quantum confinement equations
4. Characterization of nano-materials.
5. Applications of nanotechnology in electronics and chemical industries.

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

| | |
|---|---|
| CO1 | Understand the properties of nano-materials and their applications |
| CO2 | Apply chemical engineering principles to nano-particles production and scale-up |
| CO3 | Solve the quantum confinement equations |
| CO4 | Characterize nano-materials. |
| CO5 | State the applications of nanotechnology in electronics and chemical industries. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | - | - | - | - | - | - | - | - | - |
| CO2 | √ | √ | √ | √ | √ | √ | √ | - | - | - | - | - |
| CO3 | √ | - | - | - | - | - | √ | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | - | √ | - | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | - |

**Detailed syllabus:**

**Unit I**
**Introduction to Nanotechnology:** Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano sizes and properties comparison with the bulk materials, different shapes and sizes and morphology.
**Fabrication of Nanomaterials:** Top Down Approach, Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Micro emulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

**Unit II**
**Kinetics at Nanoscale:** Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface Charges, Zeta Potential and pH.

**Unit III**
**Carbon Nanomaterials:** Synthesis of carbon buckyballs, List of stable carbon allotropes extended fullerenes, metallofullerenes solid C60, bucky onions nanotubes, nanocones Difference between Chemical Engineering processes and nanosynthesis processes.
Characteristics of quantum dots, Synthesis of quantum dots, Semiconductor quantum dots, Introduction - Nanoclay Synthesis method, Applications of nanoclay.

**Unit IV**

**Nanomaterials characterization:** Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential Microscopy's SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy

**Unit V**

**Applications in Chemical Engineering:** Self-assembly and molecular manufacturing : Surfactant based system Colloidal system applications, ZnO,TiO2, Silver Nanoparticles Functional materials Applications, Production Techniques of Nanotubes, Carbon arc, bulk synthesis, commercial processes of synthesis of nanomaterials, Nanoclay, Commercial case study of nano synthesis - applications in chemical engineering, Nano inroganic materials - CaCO3 synthesis, Hybrid wastewater treatment systems, Electronic Nanodevices, sensor applications, Nanobiology: biological methods of synthesis.Applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nanomaterials, Environmental Impacts, Case Study for Environmental and Societal Impacts.

**Texts /References:**


1. Kulkarni Sulabha K., Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2. Gabor L. Hornyak., H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
5. Davies, J.H. 'The Physics of Low Dimensional Semiconductors: An Introduction', Cambridge University Press, 1998.


**C. Numerical Methods for Chemical Engineering**

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Common numerical methods and how they are used to obtain approximate solutions.
2. Numerical methods to obtain approximate solutions to mathematical problems
3. Numerical methods for various mathematical operations like interpolation, differentiation etc.
4. Accuracy of common numerical methods.

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

| | |
|---|---|
| CO1 | Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions. |
| CO2 | Apply numerical methods to obtain approximate solutions to mathematical problems |
| CO3 | Derive numerical methods for various mathematical operations like interpolation, differentiation etc. |
| CO4 | Analyze and evaluate the accuracy of common numerical methods. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | - | - | √ | - | √ | - | - | - | - | - | - |
| CO2 | √ | - | - | √ | - | √ | - | - | - | - | - | - |
| CO3 | √ | - | - | √ | - | √ | - | - | - | - | - | - |
| CO4 | √ | - | - | √ | - | √ | - | - | - | - | - | - |

**Detailed syllabus:**

**Unit I**
**Solutions of Linear Algebraic Equations -** Gauss elimination and LU decomposition, Gauss-Jordan Elimination, Guass-Seidel and relaxation methods.
**Eigen values and Eigen Vectors of Matrices -** Faddeev-Leverrier method, Power method, Householder's and Given's method

**Unit II**
**Nonlinear Algebraic Equations -** Fixed point method, Multivariable successive substitutions, Single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique

**Unit III**
**Function Evaluation -** Least-squares curve fit, Newton's Interpolation formulae, Newton's divided difference interpolation polynomial, Langrangian interpolation, Pade approximations, Cubic spline approximations

**Unit IV**
**Ordinary Differential Equations (Initial value problems) –** RungeKutta Methods, Semi-implicit RungeKutta Techniques, Step size control and estimates of error
**Ordinary Differential Equations (Boundary value problems) -** Finite difference technique, Orthogonal collocation technique, Orthogonal collocation on finite elements

**Unit V**
**Partial Differential Equations –** Introduction to finite difference technique

**Texts / References**:

S.K. Gupta, "Numerical Methods for Engineers", Wiley Eastern, 1995.
M.E. Davis, "Numerical Methods & Modeling for Chemical Engineers", Wiley, 1984.

**D. Introduction to Material Science**

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Processing, microstructure and properties of materials.
2. Behavior of materials under various conditions.
3. Design new materials with better properties and cost effective processes.
4. Materials suitable for engineering applications

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

| | |
|---|---|
| CO1 | Correlate processing, microstructure and properties of materials. |
| CO2 | Understand behavior of materials under various conditions. |
| CO3 | Characterize modes of failure of engineering materials and design new materials with better properties and cost effective processes. |
| CO4 | Identify suitable materials for engineering applications. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | √ | - | - | √ | - | √ | - | √ | - | - | - |
| CO2 | - | √ | - | - | √ | - | √ | - | √ | - | - | - |
| CO3 | - | √ | - | - | √ | - | √ | - | √ | - | - | - |
| CO4 | - | √ | - | - | √ | - | √ | - | √ | - | - | - |

**Detailed syllabus:**

**Unit I**
Materials Science and Engineering Materials, Classification of Materials an Properties:Mechanical, Dielectric, Magnetic and Thermal.

**Unit II**
Metallurgical Aspects of Materials: Structure of Metals and Alloys, Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals, Significance of micro structural features.

**Unit III**
Heat Treatment: effect of cooling and heating rates and ageing materials for mechanical load bearing applications; Corrosion Resistant Materials: Some important Metals, Alloys, Ceramics and Polymers.

**Unit IV**
Materials for Electrical Applications: Conductors, Dielectrics, insulators; Materials for Civil Engineering Applications.

**Unit V**
Materials for Biomedical applications: Steels, Ti and its alloys, Ni-Ti alloys, bioceramics, porous ceramics,
Bioactive glasses, calcium phosphates, collagen, thin films, grafts and coatings, biological functional materials Latex products.

**Texts/ References:**
1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, B H, 2005.
3. ASM Publication Vol. 20, Materials Selection and Design, ASM, 1997
4. Pat L. Mangonon: The Principles of Materials Selection and Design, PHI, 1999.

**E. Advanced Engineering Chemistry**

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Basic concepts in electrochemistry and corrosion science
2. Basic concepts in molecular interactions
3. Synthesis and analysis of modern materials
4. Concepts of organic chemistry for synthesis
5. Synthesis and applications of polymer science
6. Structure of organic molecules using photo chemistry and chemical spectroscopy

**Course Outcomes:** At the end of the course, the student will be able to:
1. Understand and apply the concepts in electrochemistry and corrosion science
2. Understand the concepts in molecular interactions
3. Understand the synthesis and analysis of modern materials
4. Apply the concepts of organic chemistry for synthesis
5. Understand the synthesis and applications of polymer science
6. Identify the structure of organic molecules using photo chemistry and chemical spectroscopy

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | - | √ | - | √ | - | √ | - | - | - |
| CO2 | √ | √ | √ | - | √ | - | √ | - | √ | - | - | - |
| CO3 | √ | √ | √ | - | √ | - | √ | - | √ | - | - | - |
| CO4 | √ | √ | √ | - | √ | - | √ | - | √ | - | - | - |
| CO5 | √ | √ | √ | - | √ | - | √ | - | √ | - | - | - |
| CO6 | √ | √ | √ | - | √ | - | √ | - | √ | - | - | - |

**Detailed syllabus**

**Unit I**
**Corrosion and its Control:** Introduction, Fundamental reason, Electrochemical Corrosion, Direct Chemical Corrosion, Factors affecting the rate of corrosion, types of corrosion-Galvanic, Pitting Corrosion, Microbiological corrosion, Stress corrosion, methods to minimize the corrosion- Proper design, Cathodic and Anodic protection. Study of Composite materials.

**Unit II: Spectroscopy:** Brief introduction to spectroscopy, UV – Visible Spectroscopy: Laws of absorption, types of transitions, instrumentation and application. FT- IR spectroscopy: introduction, theory, instrumentation and application. Brief discussion on NMR Spectroscopy and its Applications. Brief introduction of AAS (Atomic Absorption Spectroscopy)

**Unit III: Instrumental Methods of Chemical Analysis:** Introduction to Chromatography, Types of Chromatography (Adsorption and partition chromatography), Paper and Thin Layer Chromatography, Gas Chromatography – introduction, theory, instrumentation. Brief discussion of Thermo gravimetric analysis (TGA), Differential Scanning Colorimetry .

**Unit IV: Organic reaction Mechanisms:** Introduction, Electronic displacement effects in organic molecule, reactive intermediates (carbocation, carbanion and carbine), Brief introduction of Addition and Substitution and Elimination reaction with suitable examples.

**Rearrangement:** Introduction, Pinacole – Pinacolone rearrangement.

**Unit V: Drugs and Dyes:**

**Drugs:** Introduction, Study of the following drugs with reference to structure, occurrence, medicinal uses and side effects: Antipyretic: Paracetamol (synthesis), Anti Inflammatory drug: Ibuprofen, Antibiotic drugs, Anti-malarial drug: Quinine (Synthesis), Anti- Cancer drugs, Anti- hypertensive drugs.

**Dyes:** Introduction, Synthesis and uses of Synthetic dyes: Congo- red, Eriochrome black – T

**Text books:**

1. Bhal and Bhal Advance Organic Chemistry, S. Chand & Company, New Delhi, 1995.
2. Jain P.C & Jain Monica, Engineering Chemistry, DhanpatRai& Sons, Delhi, 1992.
3. Bhal&Tuli, Text book of Physical Chemistry (1995), S. Chand & Company, New Delhi.
4. Handbook of Drugs and Dyes, Himalaya Publications.

**Reference books:**

1. Finar I. L., Organic Chemistry (Vol. I & II), Longman Gr. Ltd & English Language Book Society, London.
2. Barrow G.M., Physical Chemistry, McGraw-Hill Publication, New Delhi.
3. Shikha Agarwal, Engineering Chemistry- Fundamentals and applications, Cambridge Publishers 2015.
4. O. G. Palanna , Engineering Chemistry, Tata McGraw-Hill Publication, New Delhi.
5. WILEY, Engineering Chemistry, Wiley India, New Delhi 2014.
6. Books on Drugs and Dyes, McGraw-Hill Publication, New Delhi.

## BTPCL406 Unit Operations - II Lab **2 Credit**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| LC | BTPCL406 | Unit Operations II Lab | - | - | 3 | 60 | - | 40 | 100 | 2 |

**Course Objectives:** After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Electrical analogy in relation to heat conduction
2. Emissivity of a given body.
3. Heat flow for resistances in series
4. Heat losses from cylindrical furnace
5. Temperature profiles in rod-double pipe heat exchanger, helical coil, heat pipe demonstration experiment
6. Boiling Phenomena in liquids

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

| | |
|---|---|
| CO1 | Understand the Electrical analogy in relation to heat conduction |
| CO2 | Determine Emissivity of a given body. |
| CO3 | Determine heat flow for resistances in series |
| CO4 | Determine heat losses from cylindrical furnace |
| CO5 | Determine temperature profiles in rod-double pipe heat exchanger, helical coil, heat pipe demonstration experiment |
| CO6 | Understand boiling Phenomena in liquids |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO2 | - | √ | - | - | - | - | - | - | - | - | - | - |
| CO3 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO4 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO5 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |
| CO6 | √ | √ | √ | √ | - | - | - | - | - | - | - | - |

## List of Experiments

1. To determine thermal conductivity of given metal rod
2. Study of Double Pipe Heat Exchanger
3. Study of Shell and Tube Heat Exchanger
4. Study of Study of emissivity of circular discs with and without black coating.
5. Study of Stefan-Boltzman's constant
6. To determine the surface heat transfer coefficient for a vertical tube losing heat by natural convection.

## BTPCS407 Seminar II **2 Credits**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Seminar** | BTPCS407 | Seminar - II | **-** | **-** | **4** | **60** | **-** | **40** | **100** | **2** |

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

| | |
|---|---|
| CO1 | Acquire knowledge on topics outside the scope of curriculum |
| CO2 | Communicate with group of people on different topics. |
| CO3 | Collect and consolidate required information on a topic. |
| CO4 | Prepare a seminar report and present |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | - | - | - | - | - | √ |
| CO2 | √ | √ | - | - | √ | √ | - | - | √ | √ | √ | √ |
| CO3 | - | √ | - | - | √ | - | √ | - | - | - | √ | √ |
| CO4 | - | - | - | - | | - | - | - | √ | - | √ | √ |

Each student is expected to collect information on recent advances in Chemical Engineering by regularly referring to national and international journals and reference books. At the end of the semester he/she is required prepare a report as per the guide lines prescribed by the Department. Each student will be assigned a guide for this seminar course.

Every student shall give a power point presentation on his Seminar topic before a panel of examiners.

## BTCHI408 Internship - 2 **Audit**

| Category | Code | Subject Name | L | T | P | CA | MSE | ESE | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Internship** | **BTPCI508** | **Internship - 2** | **-** | | | | | | | **Audit** |

**Field Training / Internship 2 / Industrial Training (minimum of 4 weeks, which can be completed partially in third semester and fourth semester or at one time). Credits to be evaluated in V Sem.**

**Internship- II (Industrial Training)**

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

| | |
|---|---|
| CO1 | Acquire knowledge on topics outside the scope of curriculum |
| CO2 | Communicate with group of people on different topics. |
| CO3 | Collect and consolidate required information on a topic. |
| CO4 | Prepare a seminar report and present |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | - | - | - | - | - | √ |
| CO2 | √ | √ | - | - | √ | √ | - | - | √ | √ | √ | √ |
| CO3 | - | √ | - | - | √ | - | √ | - | - | - | √ | √ |
| CO4 | - | - | - | - | - | - | - | - | √ | - | √ | √ |

Each student is expected to spend Four weeks in any one factory/project/workshop at the end of semester IV (during summer vacation). Here he/she shall observe layout, working and use of various machinery, plants, design, instruments, process etc. under the general supervision of the foreman/artisan/engineer of the factory etc. Student shall submit report in a systematic technical format about the major field of the factory, particularly about the section/department where he/she has received the training giving details of equipment, machinery, materials, process etc. with their detailed specifications, use etc. The report shall be checked and evaluated by the concerned teacher and an appropriate grade shall be awarded.