# भारतीय पेट्रोलियम और ऊर्जा संस्थान
# INDIAN INSTITUTE OF PETROLEUM AND ENERGY

## Minutes of 4th meeting of the 'Senate' IIPE, Held on 10th March, 2022 from 1030 hrs

The 4th meeting of the Senate of Indian Institute of Petroleum and Energy, Visakhapatnam was held on 10th March, 2022 at IIPE Conference Hall.

The meeting was held in virtual as well as physical Mode. Following members were present in the meeting:

| Sl. No. | Name of the Member | Nominated As |
|---|---|---|
| 01 | Prof. V.S.R.K. Prasad, Director, IIPE | Chairman (Ex-Officio) |
| 02 | Prof. Suddhasatwa Basu, | Member |
| 03 | Shri Saloma Yomdo | Member |
| 04 | Shri Mahesh Chand Gupta | Member |
| 05 | Prof. K. Vijaya Kumar | Ex-Officio Member |
| 06 | Dr. A. Seshagiri Rao | Ex-Officio Member |
| 07 | Dr. Deepak Amban Mishra | Ex-Officio Member |
| 08 | Dr. Pratibha Biswal | Ex-Officio Member |
| 09 | Dr. P. Aparoy | Ex-Officio Member |
| 10 | Dr. G. Nagesh | Ex-Officio Member |
| 11 | Dr. Rajat Jain | Ex-Officio Member |
| 12 | Dr. P. Venkata Reddy | Ex-Officio Member |
| 13 | Dr. Arun Kumar | Ex-Officio Member |
| 14 | Dr. Somnath Ghosh | Ex-Officio Member |
| 15 | Dr. Himangshu Kakati | Member |
| 16 | Dr. Ranjan Pramanik | Member |
| 17 | Dr. C.V. Rao | Member |
| 18 | Dr. R. Ramunaidu | Member |
| 19 | Dr. T. Hemanth Kumar | Member |
| 20 | Prof. B.C. Meikap | Special Invitee |
| 21 | Shri Deepak V Shastry | Special Invitee |
| 22 | Shri Rama Sakthivel | Special Invitee |
| 23 | Prof. PS Avadhani | Special Invitee |
| 24 | Dr. B. Muralikrishna | Ex-Officio Secretary |

Prof. V.S.R.K. Prasad, Hon'ble Director & Chairman (Senate), IIPE, welcomed all the members of the Senate who were present in the meeting and accordingly, the meeting was started as scheduled at 1030 AM.

INDIAN INSTITUTE OF PETROLEUM & ENERGY * VSP *

| Sl No. | Agenda of the 4th Meeting of the Senate |
|---|---|
| 1. | Confirmation of the Minutes of the 2nd & 3rd meetings of the Academic Senate of IIPE held on 25th June, 2021 & 19th January, 2022 and submission of Action Taken Report. |
| 2. | Implementation of NEP 2020 from the batches of the Admissions for the A.Y. 2022-23 onwards and the syllabus reframed accordingly. |
| 3. | Introduction of B. Tech Mechanical Engineering program as referred in the DPR from the A.Y. 2022-23. |
| 4. | Introduction of new PG program 'M.Tech Chemical Engineering' from the Academic Year 2022-23. |
| 5. | Introduction of short-term certificate courses for officials of MoPNG & Oil PSUs. |
| 6. | Rules & regulations for Ph.D, & 2-year M.Sc/ M. Tech programs. |
| 7. | Addition/ modification/ refinement of B.Tech (Chemical Engineering) course content with new format. |
| 8. | Introduction of two new courses related to Energy for Elective-4 & Elective-5 for B. Tech Courses. |
| 9. | Any other item with the permission of the chair. |

**Agenda Item No.1: Confirmation of the Minutes of the 2nd & 3rd meetings of the Academic Senate of IIPE held on 25th June, 2021 & 19th January, 2022 and submission of Action Taken Report.**

The 2nd meeting of the 'Academic Senate' of IIPE was held on 25.06.2021 & 3rd meeting was held on 19.01.2022. The minute were circulated to all the learned members through email on 30.06.2021 & 24.01.2022 respectively. The comments/ remarks were received from the learned members, have accordingly been incorporated in the relevant minutes. Action taken report om the resolutions of the 2nd & 3rd meetings of the Academic Senate of IIPE held on 25th June, 2021 & 19th January, 2022 are as follows:

| ACTION TAKEN REPORT 2ND MEETINGS OF THE ACADEMIC SENATE | | |
|---|---|---|
| **Agenda** | **Resolution** | **Action Taken** |
| **Curriculum change in Chemical Engineering as per the advice of the industries** | It was resolved to incorporate the suggestions given by the expert from the industries. | As per the discussions action is being initiated and the curriculum change in Chemical Engineering as per the advice of the industries is being successfully implemented. |
| **Curriculum change in Petroleum Engineering as per the advice of the industries** | It was resolved to accept the proposal presented by HoD Petroleum Engineering for implementation from 2021-22 session. | As per the discussions action is being initiated and the curriculum change in Petroleum Engineering as per the advice of the industry experts is being implemented and running successfully from 2021 - 22. |
| **Curriculum change in MSc Applied Geology as per the advice of the industries** | It was resolved to accept the proposed 2 new electives along with the presented course content. | Two electives are added to the curriculum planned. |
| **Curriculum change in Chemistry** | It was resolved to accept the proposal and rename the subject as 'General Chemistry' with the changes as proposed. | As per the discussion action is being initiated and implemented accordingly for 2021 –batch. |
| Any other item with the permission of the Chair. **Proposed syllabus for UG/PG courses in Computer Science** | After a prolonged deliberation, the resolutions made are as follows:<br>a) It was accepted to rename 'Information Technology' as 'Object Oriented Programming' with no change in the course content.<br>b) It was also resolved to accept the suggested changes in 'Programming and Data Structure' and 'Data Analytics and AI for Process Industry '.<br>c) The course content of the proposed course on 'cyber security' will be reviewed further and will be offered | As per the resolution points, the changes recommended for the first two Sr. Nos. a & b were implemented.<br>Sr. No. c this is to be implemented from next semester onwards.<br>Sr. No. d Process Optimization proposed as an elective for PG. It is open for UG students also. |

| | | |
|---|---|---|
| | as an audit program for both UG and PG students.<br>d) A course with name 'Process Optimizations' may be floated as an introductory subject for the 'Operations Research' course. | |

ACTION TAKEN REPORT 3RD MEETINGS OF THE ACADEMIC SENATE

| Agenda | Resolution | Action Taken |
|---|---|---|
| **Ratification of Convocation Proceedings & Award of Degrees** | Resolved to ratify the Convocation proceedings, process and award of degrees to the students of 2016-20 & 2017-21 batch students. | The first convocation of IIPE was conducted on 21st January, 2022 as per the proceedings, the degrees were awarded to all the eligible students of 2016-20 & 2017-21 both batch students successfully. |

**Approval Sought:** The Senate may confirm the minutes of its 2nd & 3rd meetings held on 25.06.2021 & 19.01.2022 respectively and may ratify the action taken report submitted by IIPE.

**Resolution:**

The committee confirmed the Minutes and action taken report of the 2nd and 3rd Senate meeting held on 25.06.2021 and 19.01.2022 respectively.

**Agenda Item No.2: Implementation of NEP 2020 from the batches of the Admissions for the A.Y. 2022-23 onwards and the syllabus reframed accordingly.**

The new 'National Education Policy 2020' for Higher Education envisages for broad based, multi-disciplinary, holistic Under-Graduate education with flexible curricula, creative combinations of subjects, integration of vocational education and multiple entry and exit points with Academic Bank of Credits and appropriate certification.

**Approval sought:** The Academic Senate is requested to consider the reframed course curriculum for B. Tech courses along with appropriate certifications (as furnished below) in line with the new NEP 2020, and may approve the same. Further, the appropriate certifications as per NEP 2020 (Source: Point No. 11.9 of National Education Policy 2020) are furnished below:

(i) 1st Year Exit: **Certificate**
(ii) 2nd Year Exit: **Diploma**
(iii) 3rd Year Exit: **Bachelor 's Degree**
(iv) 4th Year Exit: **Degree with Research**

**Resolution:**

- After a prolonged deliberation it was resolved that NEP 2020 with uniform first year syllabus and multiple entry and exit points may be adopted for B Tech program. Members of committee agreed to get admission for 2nd and 3rd year with following conditions:
  - All admission should be done on the basis of JEE Advanced marks.
  - Students should have certificate/Diploma from Institute of National Importance.
  - The gap should be of maximum of 2 years with justified reason and 5 years with having working experience.

- With regard to awarding certificate/diploma/Degree for 2nd, 3rd and 4th year of exit, Board has deliberated to form a committee for the nomenclature of the award and minimum credits to be fulfilled by the student before award of any certificate, diploma, degree. Some suggestive titles are as follows and resolved to accept the same:
    - Exit after 1st Year: **Certificate in Basic Sciences**
    - Exit after 2nd Year: **Certificate in Engineering Sciences**
    - Exit after 3rd Year: **Diploma**
    - Exit after 4th Year: **Bachelor 's Degree**

**Agenda Item No.3: Introduction of B. Tech Mechanical Engineering program as referred in the DPR.**

It is proposed to start the B. Tech Mechanical Engineering program as referred in the *Detailed Project Report (DPR)* of IIPE, from the academic year 2022-23. The goal of the 4-year B-Tech Program in Mechanical Engineering is to produce highly skilled Mechanical Engineers with specialized knowledge in petroleum and energy sectors. The admissions, with initial intake of 30 students, based on valid JEE (advanced) score, is proposed.

**Approval Sought**: The Senate is requested to consider the proposal and approve for introduction of 4-year B. Tech Mechanical Engineering program at IIPE along with the suggested course curriculum which is flexible in line with new NEP 2020.

**Resolution:**

After a prolonged discussion it was resolved that:

- B. Tech in Mechanical Engineering may be started at IIPE, from academic year 2022-23.
- The student intake will be 40 (Reservations as per the Government norms)
- The common first year UG Syllabus approved for all the three departments, from academic year 2022-23.
- The 2nd, 3rd, and 4th year syllabus will be discussed in the subsequent senate meeting after necessary modifications.
- In tune with the DPR, petroleum program shall be offered in one full semester and it is resolved to offer same in VIII Semester.

**Agenda Item No.4: Introduction of new PG program 'M. Tech Chemical Engineering' from the Academic Year 2022-23.**

The objective of the institute is to provide highly skilled manpower to petroleum & energy sectors through strong fundamental technical education and carry out collaborative research to develop the technologies that will bridge the gaps towards sustainable growth. To achieve this, a two year M.Tech program in Chemical Engineering, as referred in DPR, is proposed to be introduced from the academic year 2022-2023.
In this regard, the proposed course curriculum, admissibility conditions and other rules & regulations for award of degree of 2-year M. Tech in Chemical Engineering were presented.

**Approval Sought**: The Senate is requested to consider the proposal and approve for introduction of 2-year M. Tech in Chemical Engineering program at IIPE from the A.Y. 2022-23 along with the suggested course curriculum and rules & regulations framed therein.

**Resolution:**

The senate has agreed with the Introduction of new PG program 'M.Tech Chemical Engineering' from A.Y. 2022-23 and provided the following suggestions:

- As per Institute Norms monthly stipend will be paid to the students who enrol themselves with GATE Score.
- Candidates with B.Tech Degree from Centrally Funded Technical Institutes (CFTIs) having CGPA $\geq$ 8 shall be admitted without GATE examination. However, written test/ interview may be conducted by the department. They receive stipend at par with the regular students.
- The total number of seats with stipend is limited to 10. This may be increased at a later date based on the actual number of admissions and availability of funding from ministry/ other sources.
- Admission through QIP category shall also be included.
- In case of 10 Self-financed seats, preference may be given to Candidates coming from Industries/R & D organisations. The admission to self-sponsored candidates shall be based on written test/ interview.
- The number of credits to the Thesis Part A can be reduced to 10 and credits to Thesis Part B can be increased to 16.

**Agenda Item No.5: Introduction of short-term certificate courses for officials of MoPNG & Oil PSUs.**

It is proposed for introduction of short-term certificate courses for officials of MoPNG & Oil PSUs. The training program is aimed at providing the basics of both upstream and downstream processing methods in petroleum and natural gas production. The training program will be conducted by experienced people working in the area of upstream and downstream process technologies and related domains.

In addition to faculty of Petroleum and Chemical Engineering Departments at IIPE, experts from other relevant industries will also deliver the lectures. The program is divided into two segments consisting of upstream processes and downstream processes. It is tentatively planned to teach all the modules for a duration of 40 hours.

In this regard details of the eligibility criteria, registration fee, application format, duration of course & proposed modules under the course structure were placed for consideration.

**Approval Sought:** The Senate was requested to consider and deliberate on the above proposal and may ratify the same for introduction of the short term courses for officials of MoPNG & Oil PSUs.

**Resolution:**

Senate members have discussed and resolved for the introduction of the short term courses for officials of MoPNG & non – core staff members of Oil PSUs with following recommendations:

- The number of lectures per day should not exceed 6hours.
- The upstream and downstream courses may be imparted separately
- CCUS may be included both in upstream and downstream programs
- Topic related to Natural Gas, Petrochemicals, Green Hydrogen, LNG & CDG may be included.

**Agenda Item No.6: Rules & regulations for Ph.D, M.Sc & M.Tech programs.**

The rules & regulations for award of Ph.D degree & degrees under M.Sc & M.Tech programs, being offered by the IIPE are formulated and were presented.

**Approval sought:** The Academic Senate was requested to consider and approve the rules & regulations formulated for award of Ph. D degree & degrees under 2-year M. Sc & M. Tech programs.

**Resolution:**

It is resolved to approve for the implementation of Rules & regulations for Ph.D, M.Sc & M.Tech programs, which are in tune with those of the mentor Institute, IIT Kharagpur.

**Agenda Item No. 7: Addition/ modification/ refinement of B. Tech (Chemical Engineering) Course content with new format.**

It is proposed for the new format for course content in B. Tech Chemical Engineering which consists of the prerequisites, course objectives and learning outcomes along with minor changes in the code modification, title changes and further refinement of the course content in detailed order and were placed before the senate.

**Approval Sought:** The Senate was requested to consider the proposed changes in format for course content with code modification & title changes.

**Resolution:**

The Members of the Board has deliberately approved for the implementation of Addition/ modification/ refinement of B. Tech (Chemical Engineering) Course content with new format with minor changes as suggested with following recommendation.

- Subject code should not be changed due to the technical difficulties in ERP.

**Agenda Item No.8: Introduction of two new courses related to Energy for Elective-4 & Elective-5 for B. Tech Courses.**

It is proposed to introduce the following Electives in B. Tech Courses under Elective 4 & Elective 5 in Energy:-

**Elective 4: ENERGY STORAGE SYSTEMS:**

Scientific and engineering fundamentals of all major energy storage methods, different types of energy storage systems (ESS) and their working principals, storage of energy as hydroelectric pumped storage, thermal, compressed air storage, fly wheel storage, mechanical, electrostatic and magnetic systems, phase transitions and reversible chemical reactions, organic fuels and hydrogen, electro-chemical systems; energy storage technologies; basics of batteries; materials and methods, electrochemical ESS types; safety issues; model codes and standards; traditional and emerging battery systems, EV and automotive technologies.

**Elective 5: HYDROGEN ENERGY:**

Introduction of hydrogen energy systems, current status of production, storage and utilization, hydrogen production processes, steam reformation, gasification, pyrolysis, oxidative and non-oxidative processes, green hydrogen production using nuclear energy and renewables- wind, biomass, solar; separation and purification; storage, compressed storage, liquid state storage, solid state storage, different materials for storage, Zeolites, Metal hydride storage, chemical hydride storage; hydrogen sensing, hydrogen utilization, hydrogen safety.

**Approval Sought:** The Senate was requested to consider and may ratify the same for introduction of Elective 4 & Elective 5 in Energy, as proposed above.

**Resolution:**
The Members of the senate has approved for the addition of two new elective courses related to Energy for Elective-4 & Elective-5 for B. Tech Courses.

**Agenda Item No.9: Any other item with the permission of the chair.**

As there are no other items for the discussion, the meeting was concluded with vote of thanks by Dr. B. Murali Krishna, (Registrar i/c) Ex-officio Secretary, Senate

This is issued with the approval of the Chairman, Senate IIPE.

Date: 29.03.2022

Registrar (I/c)
& Ex-officio Secy., Senate

REGISTRAR
INDIAN INSTITUTE OF PETROLEUM & ENERGY
VISAKHAPATNAM

# भारतीय पेट्रोलियम और ऊर्जा संस्थान
# INDIAN INSTITUTE OF PETROLEUM AND ENERGY

## Minutes of the 3rd meeting of the 'Academic Senate' IIPE, held on 19th January, 2022 (Wednesday) from 1030 hrs both offline & online through CISCO Webex

**Agenda Item No. 1: Ratification of Convocation Proceedings & Award of Degrees.**

The 1st Convocation of IIPE is scheduled to be held on 21st January, 2022 from 10:30 AM at VMRDA Children's Arena, Visakhapatnam. The Hon'ble Vice President of India Shri. M Venkaiah Naidu Garu has kindly consented to be the Chief Guest and will deliver the Convocation address and bless the students on this occasion. Shri Rameswar Teli, the Hon'ble Minister of State of Petroleum & Natural Gas and Labour and Employment will be the Guest of Honour for the event.

In the present convocation, there are 170 students from the batches of 2016-20 and 2017-21 are being awarded with the degrees. Three students from each batch are receiving the gold medals and merit certificates.

In view of the present pandemic situation, the program is also live telecasted through IIPE YouTube channel (https://www.youtube.com/channel/UC7ypqSTAWAZLwnpcTQV9b7w).

The event is being conducted by duly following all COVID-19 protocols and in accordance with extant orders of the Government.

The copies of Convocation Proceedings and Convocation Brochure is placed at Annexure – 1.

**Approval Sought:** The Academic Senate may consider and ratify the convocation proceedings, process and award of degrees to the students of 2016-20 & 2017-21 batch students.

**Resolution:** Resolved to ratify the Convocation proceedings, process and award of degrees to the students of 2016-20 & 2017-21 batch students.

**Agenda Item No. 2: Any other item with the permission of the Chair.**

INDIAN INSTITUTE OF PETROLEUM & ENERGY * VSP *

24/1/22

REGISTRAR
INDIAN INSTITUTE OF PETROLEUM & ENERGY
VISAKHAPATNAM

**Members present**

1. Dr. VSRK Prasad, Director, IIPE – **Chairman;**
2. Prof. B.C. Meikap, SPOC, Mentor Institute - Member;
3. Dr. Deepak Amban Mishra, Assistant Professor, Associate Dean Academic Affairs & Admin) - Member;
4. Dr. Somnath Ghosh, Assistant Professor, Associate Dean (Faculty Affairs) - Member;
5. Dr. Pratibha Biswal, Assistant Professor, Associate Dean (Students' Affairs) - Member;
6. Dr. P Aparoy, Assistant Professor, Associate Dean (R&D) - Member;
7. Dr. G Nagesh, Assistant Professor, Associate Dean (Planning Resources & Alumni) - Member;
8. Dr. Rajat Jain, Assistant Professor, HoD, Petroleum Engineering - Member;
9. Dr. P Venkata Reddy, Assistant Professor, HoD, Chemical Engineering - Member;
10. Dr. R. Ramunaidu, Assistant Professor - Member;
11. Dr. Ranjan Pramanik, Assistant Professor - Member;
12. Dr. C. Veerabhadra Rao, Assistant Professor - Member;
13. Dr. T Hemanth Kumar, Assistant Professor - Member;
14. Dr. Himangshu Kakati, Assistant Professor - Member;
15. Dr. B. Muralikrishna, Registrar (I/c), IIPE – Ex-officio Secretary.

# INDIAN INSTITUTE OF PETROLEUM & ENERGY

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**Andhra University, Visakhapatnam - 530 003**
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Ref: IIPE/ 2nd AS Meeting/2021/002 Date: 25.06.2021

Minutes of the 2nd meeting of the Academic Senate, IIPE held on 25th June, 2021 at 11.00 AM offline and through Cisco WebEx (virtual meeting).

**MEMBERS PRESENT: -**

Prof. V.S.R.K Prasad, Director (in Chair);
Prof. S Neogi, IIT Kharagpur, SPOC, (Mentor Institute);
Shri. Rama Sakthivel, Site Manager, Shell Technology Centre Bangalore;
Shri. Mahesh Chand Gupta, CGM (Trg. & Skill Dev.), GAIL
Shri. Deepak V Shastry, Ex - Executive Director, (Training R&D and Start Up), GAIL Special Invitee
Dr. Pratibha Biswal, Assistant Professor, Associate Dean (Students' Affairs);
Dr. P Aparoy, Asst. Professor, Associate Dean (R&D);
Dr. G Nagesh, Asst. Professor, Associate Dean (Planning Resources & Alumni);
Dr. Deepak Amban Mishra, Asst. Professor, Associate Dean (Academic Affairs & Admin);
Dr. Somnath Ghosh, Asst. Professor, Associate Dean (Faculty Affairs);
Dr. Rajat Jain, Asst. Professor, DIC (PE);
Dr. P Venkata Reddy, Asst. Professor, DIC (CHE);
Dr. Arun Kumar Pujari, Asst. Professor, DIC (Mech. Engg & other Engg Programs);
Dr. Ramunaidu, Assistant Professor, DIC Examination Cell;
Dr. T Hemanth Kumar, Asst. Professor;
Dr. Himangshu Kakati, Asst. Professor;
Dr. Ranjan Pramanik, Assistant Professor, Petroleum Engg;
Dr. C. Veerabhadra Rao, Assistant Professor, CSE;
Dr. B Murali Krishna, Registrar I/c, Member Secretary;

**Members Absent with the permission of the Chair: -**

Shri. Ratan Raju, Executive Director, HPCL, Visakh Refinery;
Shri. Saloma Yomdo, CGM (RES) & Head, COEES;

**Agenda: -**

1. Curriculum change in Chemical Engineering as per the advice of the industries
2. Curriculum change in Petroleum Engineering as per the advice of the industries
3. Curriculum change in Earth Sciences as per the advice of the industries
4. Curriculum change in Chemistry
5. Any other item with the permission of the Chair.

The Chairman in his introduction informed the necessity for the proposals made in the curricula modification. He informed that two committees were formed by the Joint Secretary, MoPNG to propose changes in the course curriculum for IIPE and RGIPT, according to the requirements of the Industries. The committees chaired by Mr Pushp Kumar Joshi, Director (HR) of HPCL and Dr SSV Ramakumar Director (R&D) of IOCL respectively, worked towards proposing suggestions that would supplement industry needs and provide gainful employment to the students. (The detailed suggestions given by various industries are given in Annexure IA & IB).

**Agenda Point 1: - Curriculum change in Chemical Engineering as per the advice of the industries**

The following topics are to be added to the subjects mentioned below as per the industry experts' suggestions.

| S.No. | Sem | Subject name | Subject code | Proposed additional topics |
|---|---|---|---|---|
| 1 | II | Intro to Chemical Engineering | CH 10002 | Case studies: Application of the above concepts in context of Process flow diagrams for fertilizer. Petrochemical and Refinery dealt in Chemical Process Technology. |
| 2 | IV | Heat transfer | CH 20003 | Introduction to Pinch analysis for simple heat exchanger network |

| | | | | |
|---|---|---|---|---|
| 3 | V | Biochemical Engineering | CH 30006 | Anaerobic digestion and fermentation for the food Industry. |
| 4 | V | Particle technology | CH 30003 | Particle size distribution including (normal/Gaussian) |
| 5 | V | Reaction engineering - II | CH 30002 | Scale-up parameters/methodology for a typical multiphase flow type reactor |
| 6 | VI | Process Equipment design | CH 30008 | Fundamental aspects of process data sheet and interpretation of process data sheet for major equipment used in refinery - heat exchanger, distillation Column, Internals, Pump, Pipes, Control valve |
| 7 | VII | Process safety | BS 40001 | Hydrocarbon storage, Handling of cryogenic fluids and metallurgy<br><br>Awareness on Statutory Bodies & Regulations viz. PESO, OISD, ISO standards<br><br>Industrial safety and hazards |
| 8 | VI | Elective -I<br><br>Wastewater Management | CH30010 | Up flow anaerobic sludge blanket, issues related to water treatment in large size industrial set up, clearing of water bodies /rivers in the context of Ganga Action plan and other initiatives. |

**Approval sought**: -

IIPE seeks approval for the implementation of the curriculum change in Chemical Engineering as per the advice of the industries.

**Resolution**: -

It was resolved to incorporate the suggestions given by the expert from the industries.

**Agenda Point 2: - Curriculum change in Petroleum Engineering as per the advice of the industries**

**A**) Addition of a new elective '**Natural Gas Engineering**' in Elective 4.

Importance of Natural Gas; Composition of Natural Gas, Natural Gas Reservoir, Unconventional gas reserve. Properties of Natural Gas: Phase Behavior, properties of Natural Gas, Formation Volume Factor, etc., Determination of natural gas properties such as specific gravity, pseudocritical properties, viscosity, compressibility factor, gas density, formation and expansion volume, and compressibility.

Production of Natural Gas: Overview of well Completion and wellbore Performance.

Natural Gas Processing & surface facilities: Gas Compressor, Compressor design, Gas Flow Measurement, Principle of Separator, Design of Separator. Dehydration of Natural Gas, Design of Dehydration, Sweeting processes and sulphur recovery, Processing of LPG, CNG system, Conversion of gas to liquid

Gas Gathering system, transportation and Storage: Gas Gathering system, Transmission of Natural gas, Transportation and Measurement, Pipeline Design. Flow through pipeline, issues and solutions. Underground storage.

Gas Supply/Distribution: City Gas/CNG development, CNG stations, Design aspects for City Gas Network and CNG Stations, Maintenance and safety of City Gas Networks and CNG equipment.

**B**) New course structure for PE students (proposed to be adopted from 2020 batch onwards)

| SEM | Proposed to be Removed/Shifted/Renamed | Proposed to be Added |
|---|---|---|
| I | **No Change** | |
| II | **No Change** | |
| III | 1. Information Technology [2-0-3] (4 Cr) | 1. Drilling Technology [3-1-0] (4 Cr) |
| IV | 2. Phase Equilibria Thermodynamics [3-1-0] (4 Cr)<br>3. Transport in Porous Media [3-0-0] (3 Cr)<br>4. Fluid flow lab & Design [0-0-3] (2 Cr) | 1. Elements of Reservoir Engineering [3-1-0] (4 Cr)<br>2. HC Production Engineering- I [3-1-0] (4 Cr)<br>3. Petroleum Geology Lab [0-0-3] (2 Cr) |

| | | |
|---|---|---|
| **V** | 1. Drilling Technology [3-1-0] (4 Cr)<br>2. Reservoir Engineering I [3-1-0] (4 Cr)<br>3. HC Production Engineering- I [3-1-0] (4 Cr)<br>4. Instrumentation & Process Control [3-1-0] (4 Cr) | 1. Information Technology [2-0-3] (4 Cr)<br>2. Transport in Porous Media [3-0-0] (3 Cr)<br>3. Advanced Reservoir Engineering [3-1-0] (4 Cr)<br>4. HC Production Engineering II [3-1-0] (4 Cr)<br>5. Advanced Drilling Technology [3-0-0] (3 Cr) |
| **VI** | 1. Reservoir Engineering II [3-1-0] (4 Cr)<br>2. HC Production Engineering II [3-1-0] (4 Cr)<br>3. Advanced Drilling Technology [3-0-0] (3 Cr)<br>4. IPC Lab [0-0-3] (2 Cr) | 1. Oil and Gas Well Testing [3-1-0] (4 Cr)<br>2. Offshore & Deep Sea Technology [3-0-0] (3 Cr)<br>3. Enhanced Oil Recovery [3-0-0] (3 Cr)<br>4. Production Engineering Lab [0-0-3] (2 Cr) |
| **VII** | 1. Process Safety [1-0-0] (1 Cr)<br>2. Production Engineering Lab [3-0-0] (3 Cr) | 1. Health Safety and Environment [2-0-0] (2 Cr) |
| **VIII** | **No Change** | |

| | | | | | |
|---|---|---|---|---|---|
| Elective-I | Petroleum Explorations | Bio Energy | Waste Water Management | Management Techniques for Industrial Sector | Instrumentation and Process Control (*for PE students*) |
| Elective-II | Uncoventional Energy Resources | Solar Energy, Photovoltaic Energy | Advanced Separation | Advanced Material Design | |
| Elective-III | Petroleum Engineering System Design | Nuclear wind and geothermal energy | Hazardous Waste treatment and safety devices | Analytical Techniques | |
| Elective-IV | Natural Gas Engineering | Petroleum Refinery Engineering | Air Pollution | Advanced Reservoir Modelling | Microfluidics Technology |
| Elective-V | Prospecting, Filed Development and Asset Management | Petrochemical Technology | Nano Materials for Hydrocarbon Industry | Process Modelling and Simulation | |

| | Existing credits | | | | Proposed Changes | | | |
|---|---|---|---|---|---|---|---|---|
| **SEM** | **L** | **T** | **P** | **Credit** | **L** | **T** | **P** | **Credit** |
| 1 | 16 | 4 | 8 | 25 | 16 | 4 | 8 | 25 |
| 2 | 16 | 3 | 9 | 25 | 16 | 3 | 9 | 25 |
| 3 | 12 | 2 | 14 | 22 | 13 | 3 | 11 | 22 |
| 4 | 15 | 2 | 11 | 23 | 15 | 3 | 11 | 24 |
| 5 | 14 | 4 | 3 | 20 | 16 | 2 | 6 | 22 |
| 6 | 17 | 2 | 6 | 23 | 17 | 1 | 6 | 22 |
| 7 | 13 | 1 | 9 | 22 | 14 | 1 | 6 | 21 |
| 8 | 8 | 0 | 12 | 18 | 8 | 0 | 12 | 18 |
| **Total** | **111** | **18** | **72** | **178** | **115** | **17** | **69** | **179** |

**Detail proposal is attached as Annexure II**

**C) The suggestions given by the industries in the existing/offered courses for inclusion of new topics (Refer Annexure IB)**

**D) Suggestions sent by Dr. Saloma Yomdo, CGM, OIL are given below:**

(i) In Semester-VII (Reservoir Simulation), in the Syllabus content on "Multiphase flow in one-dimension, simultaneous solution methods, Implicit Pressure Explicit Saturation method" Fully Implicit and Adoptive Implicit methods may also be added along with Implicit Pressure and Explicit Saturation method, as Fully Implicit is the most widely used solver technique in industry standard simulators and IMPES is generally used in Streamline simulators. Also, merits and demerits of the different solution techniques may be added.

(ii) 'Petroleum Economics' may be clubbed/included in the VII or VIII semester.

**Approval sought**: -

IIPE seeks approval for the implementation of the curriculum change in Petroleum Engineering as per the advice of the industry experts.

**Resolution**: -

It was resolved to accept the proposal presented by HoD Petroleum Engineering for implementation from 2021-22 session with minor additions as follows:

1. Natural Gas Engineering course should include one chapter on LNG and the course can be floated from Autumn 2020-21 session.
2. Experiments from Fluid flow lab should be included in the production lab
3. Fundamentals of Heat Transfer need to be included in Transport through the porous media course.
4. Instrumentation and Process Control may be offered as elective in 7$^{th}$ Semester.

5. Carbon Capture and Sequestration should be included in EOR.
6. It was resolved to include suggestions made by Mr. Mahesh Chandra Gupta, related to inclusion of new topics in the offered/existing courses and should be taught by respective course coordinator/faculty.
7. It was resolved to include suggestions given by Dr. Saloma, OIL for the course of Reservoir Simulation. The "Economics" course is being offered in 6th semester to the students.

**Agenda Point 3: - Curriculum change in MSc Applied Geology as per the advice of the industries**

Addition of 2 new electives:

1. **Applied Micro-Palaeontology** (3credits)

   Systematic Micropaleontology: foraminifera, calcareous nannoplankton, ostracodes, pteropods, calpionellids, calcareous algae, bryozoa, radiolaria, diatoms, and silicoflagellates, ebridians, conodonts, dinoflagellates, acritarchs, tasmanitids, chitinozoa, spores and pollen. Microfossils' guide. Assemblages. Biostratigraphic units. Biostratigraphic scales and correlations. Paleoecological, paleogeographic, paleoclimatic and paleoceanographic interpretations.

   Surface and subsurface sampling methods for micro palaeontological studies; brief description of major microfossil groups used in hydrocarbon exploration; paleo-environmental interpretation using microfossils; bio stratigraphic classification, dating and correlation of stratigraphic sequences, standard planktonic foraminiferal zones; application of micropalaeontology in sequence stratigraphy; case studies from Indian sedimentary basins.

2. **Managerial Economics** (3 credits)

   *The Central Concepts of Economics and Nature and Scope of Managerial Economics*: The Concepts of Scarcity, Choice, Opportunity Costs and Efficiency; The Modern Mixed Economy-Market and Government; The basic process of decision making: Demand, Supply and Markets; Equilibrium and Surplus; Quotas, and Price Ceilings

   *Behavior of the Consumer-Demand and Demand Analysis*: Demand analysis of consumer and Elasticities of Demand; Demand estimation and Forecasting

   *Behavior of the Firm-Production and Cost Analysis:* Production Theory: Short-run and Long-run Production Functions; Cost Theory: Short-run and Long-run Cost Functions

   *Market Structure and Pricing*: Market structure and degree of competition; Price determination under different Market Structure- Short-run and Long-run Analysis,

   *Regulations and Risks*: Regulations and Role of Government in the Economy; Risk and Uncertainty in Managerial Decision Making-Mergers and Acquisitions

*Project Evaluation and Long-run Investment Decisions*: Capital Budgeting and its Process-NPV, IRR; Project Evaluation: Capital Rationing and Profitability Index

**Approval sought**: -

IIPE seeks approval for the addition of 2 new electives (Applied Micropaleontology and Managerial Economics) in MSc Applied Geology as per the advice of the industries.

**Resolution**: -

It was resolved to accept the proposed 2 new electives along with the presented course content.

**Agenda Point 4: - Curriculum change in Chemistry**

| Particulars | Existing | Proposing |
|---|---|---|
| Code | BS 10002 | BS 10002 |
| Title | Physical Chemistry | General Chemistry |
| Credit | 04 | 04 |
| No of Hour | 50 | 50 |
| Content | **Thermodynamics of Chemical Processes:** Concept of entropy, Chemical potential, Equilibrium conditions for closed systems, Phase and reaction equilibria, Maxwell relations, Real gas and real solution. [20L]<br><br>**Electrochemical Systems:** Electrochemical cells and EMF, Applications of EMF measurements: Thermodynamic data, activity coefficients, solubility product and pH, corrosion. [08L]<br><br>**Kinetics of Chemical Reactions:** Reversible, consecutive and parallel reactions, Steady state approximation, Chain reactions, Photochemical kinetics. [08L]<br><br>**Bonding Models in Inorganic Chemistry:** Molecular orbital theory, Valence-bond theory, Crystal field theory. [08L] | **Thermodynamics of Chemical Processes:** Concept of entropy, Chemical potential, Equilibrium conditions for closed systems, Phase and reaction equilibria, Maxwell relations, Real gas and real solution. [20L]<br><br>**Electrochemical Systems:** Electrochemical cells and EMF, Applications of EMF measurements: Thermodynamic data, activity coefficients, solubility product and pH, corrosion. [08L]<br><br>**Kinetics of Chemical Reactions:** Reversible, consecutive and parallel reactions, Steady state approximation, Chain reactions, Photochemical kinetics. [08L]<br><br>**Basic hydrocarbon chemistry:** Alkane, Alkene, Alkyne: (their) structure, stereochemistry, physical and chemical properties, chemical reactivity, separation. [08L]<br><br>**Basic Concept of Spectroscopy:** |

| | | |
|---|---|---|
| | **Basic Concept of Spectroscopy:** Fundamentals of Microwave, IR and UV-VIS Spectroscopy, Selection rule, Determination of molecular structure. [06L] | Fundamentals of Microwave, IR and UV-VIS Spectroscopy, Selection rule, Determination of molecular structure. [6L] |
| Basis to change | Chemical bonding deals with the theoretical models to predict shape-structure and certain chemical properties. The concept on Basic Hydrocarbon chemistry will help the learner to deal with their core courses in both Chemical Engineering and Petroleum Engineering. | |

**Approval sought**: -

IIPE seeks approval to change the name of the 'Physical Chemistry' course to 'General Chemistry'; to add a chapter on organic chemistry and to implement the suggested changes in Chemistry from autumn 2021-22 session.

**Resolution**: -

It was resolved to accept the proposal and rename the subject as 'General Chemistry' with the changes as proposed.

**Agenda Point 5: -** Any other item with the permission of the Chair.

**Proposed syllabus for UG/PG courses in Computer Science**

**Approval sought**: -

IIPE seeks approval to add one new course and modify four courses at UG level and to add one audit course of computer science in the PG program to the existing syllabus of B.Tech Chemical Engineering and Petroleum Engineering and for the PG programs to be offered. They are as mentioned below:

1) Fundamentals of Cyber Security
2) Programming and Data Structures
3) Object Oriented Programming
4) Operations Research
5) Data Analytics and AI for Process Industry
6) Cyber Security

**Resolution**: -

After a prolonged deliberation, the resolutions made are as follows:

- It was accepted to rename 'Information Technology' as 'Object Oriented Programming' with no change in the course content.
- It was also resolved to accept the suggested changes in 'Programming and Data Structure' and 'Data Analytics and AI for Process Industry '.
- The course content of the proposed course on 'cyber security' will be reviewed further by the honorable senate member Mr. Rama Sakthivel from Shell India. It is resolved to offer this program as an audit program for both UG and PG programs.
- A course with name 'Process Optimizations' may be floated as an introductory subject for the 'Operations Research' course.

As there are no more topics to be discussed, the meeting ended with a note of Vote of Thanks proposed by Dr B. Muralikrishna, the I/c Registrar of IIPE, the ex-officio Secretary.

27/7/21.

Registrar (I/c)

REGISTRAR
INDIAN INSTITUTE OF PETROLEUM & ENERGY
VISAKHAPATNAM

# INDIAN INSTITUTE OF PETROLEUM & ENERGY
## VISAKHAPATNAM

### Course Curriculum for B.Tech in Chemical Engineering

**SEMESTER I**

| S. No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 10001 | Engineering Mathematics – I | 3-1-0 | 4 |
| 2 | BS 10002 | Physical Chemistry | 3-1-0 | 4 |
| 3 | BS 10003 | Engineering Mechanics | 3-1-0 | 4 |
| 4 | BS 10005 | Earth Energy and Environment | 2-0-0 | 2 |
| 5 | BS 10009 | Fundamentals of Electrical Systems | 3-1-0 | 4 |
| 6 | BS 10006 | English for Communication | 1-0-2 | 2 |
| 7 | BS 10011 | Engineering Drawing & Computer Graphics | 1-0-3 | 3 |
| 8 | BS 19002 | Physical Chemistry Lab | 0-0-3 | 2 |
| 9 | EA 10001 | EAA – 1 | 0-0-2 | 0 |
| | | **Total** | **16-4-8** | **25** |

No change

| S. No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 10001 | Engineering Mathematics – I | 3-1-0 | 4 |
| 2 | BS 10002 | Physical Chemistry | 3-1-0 | 4 |
| 3 | BS 10003 | Engineering Mechanics | 3-1-0 | 4 |
| 4 | BS 10005 | Earth Energy and Environment | 2-0-0 | 2 |
| 5 | BS 10009 | Fundamentals of Electrical Systems | 3-1-0 | 4 |
| 6 | BS 10006 | English for Communication | 1-0-2 | 2 |
| 7 | BS 10011 | Engineering Drawing & Computer Graphics | 1-0-3 | 3 |
| 8 | BS 19002 | Physical Chemistry Lab | 0-0-3 | 2 |
| 9 | EA 10001 | EAA – 1 | 0-0-2 | 0 |
| | | **Total** | **16-4-8** | **25** |

## SEMESTER II

## Existing:

| S. No | Subject code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 10007 | Engineering Mathematics – II | 3-1-0 | 4 |
| 2 | BS 10008 | Strength of Materials | 3-1-0 | 4 |
| 3 | CH 10001 | Polymers & Surfactants | 3-0-0 | 3 |
| 4 | BS 10004 | Programming and Data Structure | 3-1-3 | 6 |
| 5 | PE 10002 | Introduction to Chemical Engineering | 2-0-0 | 2 |
| 6 | BS 10010 | Fundamentals of Biological Systems | 2-0-0 | 2 |
| 7 | BS 19012 | Organic Chemistry Lab | 0-0-3 | 2 |
| 8 | BS 19009 | Electrical Systems Lab | 0-0-3 | 2 |
| 9 | EA 10002 | EAA - 2 | 0-0-2 | 0 |
| | | **Total** | **16-3-9** | **25** |

## Modified:

| S. No | Subject code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 10007 | Engineering Mathematics – II | 3-1-0 | 4 |
| 2 | BS 10008 | Strength of Materials | 3-1-0 | 4 |
| **3** | **BS** | **Introduction to Material Science** | **3-0-0** | **3** |
| 4 | BS 10004 | Programming and Data Structure | 3-1-3 | 6 |
| 5 | BS 10010 | Fundamentals of Biological Systems | 2-0-0 | 2 |
| 6 | BS 19012 | Organic Chemistry Lab | 0-0-3 | 2 |
| 7 | BS19009 | Electrical Systems Lab | 0-0-3 | 2 |
| 8 | BS20006 | Workshop | 0-0-3 | 2 |
| 9 | EA 10002 | EAA – 2 | 0-0-2 | 0 |
| | | **Total** | **14-3-12** | **25** |

## SEMESTER III

## Existing:

| S. No | Subject code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 20001 | Transform Calculus, Probability & Statistics | 3-0-0 | 3 |
| 2 | BS 20007 | Numerical Methods | 1-0-3 | 3 |
| 3 | BS 20002 | Fluid Mechanics and Multiphase Flow | 3-1-0 | 4 |
| 4 | CH 20001 | Chemical Process Calculations | 3-1-0 | 4 |
| 5 | BS 20004 | Object Orient Programming | 2-0-3 | 4 |
| 6 | BS 20005 | Innovations Lab | 0-0-3 | 2 |
| 7 | BS 20006 | Workshop | 0-0-3 | 2 |
| 8 | EA 10003 | EAA III | 0-0-2 | 0 |
| | | **Total** | **12-2-14** | **22** |

## Modified:

| S. No | Subject code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 20001 | Transform Calculus, Probability & Statistics | 3-0-0 | 3 |
| 2 | BS 20007 | Numerical Methods | 1-0-3 | 3 |
| 3 | CH 10002 | Introduction to Chemical Engineering | 2-0-0 | 2 |
| 4 | BS 20002 | Fluid Mechanics and Multiphase Flow | 3-1-0 | 4 |
| 5 | CH 20001 | Chemical Process Calculations | 3-1-0 | 4 |
| 6 | BS 20004 | Object Orient Programming | 2-0-3 | 4 |
| 7 | BS 20009 | Fuel Lab | 0-0-3 | 2 |
| 8 | EA 10003 | EAA III | 0-0-2 | 0 |
| | | **Total** | **14-2-11** | **22** |

## SEMESTER IV

## Existing:

| S.No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 20003 | Advanced Statistical Techniques | 3-0-0 | 3 |
| 2 | CH 20002 | Chemical Engineering Thermodynamics | 3-1-0 | 4 |
| 3 | CH 20003 | Heat Transfer | 3-1-0 | 4 |
| 4 | CH 20004 | Chemical Process Technology | 3-0-0 | 3 |
| 5 | CH 20005 | Chemical Reaction Engineering | 3-0-0 | 3 |
| 6 | BS 20008 | Fluid Flow Lab and Design | 0-0-3 | 2 |
| 7 | BS 20009 | Fuel Lab | 0-0-3 | 2 |
| 8 | EA 10004 | EAA IV | 0-0-3 | 0 |
| | | **Total** | **15-2-9** | **21** |

## Modified:

| S.No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 20003 | Advanced Statistical Techniques | 3-0-0 | 3 |
| 2 | CH 20002 | Chemical Engineering Thermodynamics | 3-1-0 | 4 |
| 3 | CH 20003 | Heat Transfer | 3-1-0 | 4 |
| 4 | CH 20004 | Chemical Process Technology | 3-0-0 | 3 |
| 5 | CH 20005 | Chemical Reaction Engineering | 3-0-0 | 3 |
| 6 | BS 20008 | Fluid Flow Lab and Design | 0-0-3 | 2 |
| 7 | CH 30003 | Particle Technology | 2-0-0 | 2 |
| 8 | EA 10004 | EAA IV | 0-0-3 | 0 |
| | | **Total** | **15-2-9** | **21** |

**SEMESTER V**

## Existing:

| S. No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 30001 | Industrial psychology & Professional Ethics | 2-0-0 | 2 |
| 2 | CH 30001 | Mass Transfer I | 3-1-0 | 4 |
| 3 | CH 30002 | Reaction Engineering II | 3-1-0 | 4 |
| 4 | BS 30002 | Instrumentation and Process Control | 3-1-0 | 4 |
| 5 | CH 30003 | Particle Technology | 2-0-0 | 2 |
| 6 | CH 30006 | Bio Chemical Engineering | 3-1-0 | 3 |
| 7 | CH 30009 | Reaction Engineering Laboratory | 0-0-3 | 2 |
| 8 | CH 30004 | Heat Transfer & Particle Technology Lab | 0-0-3 | 2 |
| | | **Total** | **16-4-6** | **23** |

## Modified:

| S. No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | BS 30001 | Industrial psychology & Professional Ethics | 2-0-0 | 2 |
| 2 | CH 30001 | Mass Transfer I | 3-1-0 | 4 |
| 3 | CH 30002 | Reaction Engineering II | 3-1-0 | 4 |
| 4 | BS 30002 | Instrumentation and Process Control | 3-1-0 | 4 |
| 5 | CH 30006 | Bio Chemical Engineering | 3-1-0 | 3 |
| 6 | CH 30009 | Reaction Engineering Laboratory | 0-0-3 | 2 |
| 7 | CH 30004 | Heat Transfer & Particle Technology Lab | 0-0-3 | 2 |
| | | **Total** | **14-4-6** | **21** |

## SEMESTER VI

## Existing:

| S.No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | CH 30005 | Mass Transfer II | 3-1-0 | 4 |
| 2 | CH40002 | Transport Phenomena | 3-1-0 | 4 |
| 3 | CH 30007 | Computer Aided Process Engineering | 1-0-3 | 3 |
| 4 | CH 30008 | Process Equipment Design | 2-0-4 | 4 |
| 5 | | Elective - I | 3-0-0 | 3 |
| 6 | BS 30003 | Economics | 2-0-0 | 2 |
| 7 | BS 30004 | Instrumentation and Process Control Laboratory | 0-0-3 | 2 |
| | | **Total** | **14-2-10** | **22** |

## Modified:

| S.No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | CH 30005 | Mass Transfer II | 3-1-0 | 4 |
| 2 | CH40002 | Transport Phenomena | 3-1-0 | 4 |
| 3 | CH 30007 | Computer Aided Process Engineering | 1-0-3 | 3 |
| 4 | CH 30008 | Process Equipment Design | 2-0-3 | 4 |
| 5 | | Elective - I | 3-0-0 | 3 |
| 6 | BS 30003 | Economics | 2-0-0 | 2 |
| 7 | BS 30004 | Instrumentation and Process Control Laboratory | 0-0-3 | 2 |
| 8 | | Innovations Lab | 0-0-3 | 2 |
| | | **Total** | **14-2-12** | **24** |

## SEMESTER VII

**Existing:**

| S.No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | | Elective II | 3-0-0 | 3 |
| 2 | BS 40002 | Data Analytics and AI for Process Industry | 3-0-0 | 3 |
| 3 | CH 40001 | Project Engineering and Management | 3-0-0 | 3 |
| 4 | BS 40001 | Process Safety | 1-0-0 | 1 |
| 5 | BS 48001 | Industrial Training | 0-0-0 | 2 |
| 6 | CH 40003 | Mass Transfer Lab | 0-0-3 | 2 |
| 7 | BS 47001 | Project I | 0-0-6 | 4 |
| | | **Total** | **10-0-9** | **18** |

**No Change in Semester VII:**

## SEMESTER VIII

**Existing:**

| S. No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | CH 40005 | Process Integration and System Design | 3-1-0 | 4 |
| 2 | | Elective III | 3-0-0 | 3 |
| 3 | | Elective IV | 3-0-0 | 3 |
| 4 | | Elective V | 2-0-0 | 2 |
| 5 | BS 47002 | Project II | 0-0-9 | 6 |
| 6 | BS 48002 | Comprehensive Viva-Voce | 0-0-0 | 2 |
| | | **Total** | **11-1-9** | **20** |

**Modified:**

## SEMESTER VIII

| S. No | Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|---|
| 1 | CH 40005 | Process Integration and System Design | 3-1-0 | 4 |
| 2 | | Elective III | 3-0-0 | 3 |
| 3 | | Elective IV | 3-0-0 | 3 |
| 4 | | Elective V | 3-0-0 | 3 |
| 5 | BS 47002 | Project II | 0-0-9 | 6 |
| 6 | BS 48002 | Comprehensive Viva-Voce | 0-0-0 | 2 |
| | | **Total** | **12-1-9** | **21** |

# COURSE STRUCTURE (Petroleum Engineering)

## First Year (Common for all branches)

| Semester-I | | | | |
|---|---|---|---|---|
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 10001 | Engineering Mathematics – I | 3 - 1 - 0 | 4 |
| 2 | BS 10002 | Physical Chemistry | 3 - 1 - 0 | 4 |
| 3 | BS 10003 | Engineering Mechanics | 3 - 1 - 0 | 4 |
| 4 | BS 10005 | Earth Energy and Environment | 2 - 0 - 0 | 2 |
| 5 | BS 10009 | Fundamentals of Electrical Systems | 3 - 1 - 0 | 4 |
| 6 | BS 10006 | English for Communication | 1 - 0 - 2 | 2 |
| 7 | BS 10011 | Engineering Drawing & Computer Graphics | 1 - 0 - 3 | 3 |
| 8 | BS 19002 | Physical Chemistry Lab | 0 - 0 - 3 | 2 |
| 9 | EA 10001 | EAA – 1 | 0 - 0 - 0 | 0 |
| | | **Total** | **16 - 4 - 8** | **25** |
| **Semester-II** | | | | |
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 10007 | Engineering Mathematics – II | 3 - 1 - 0 | 4 |
| 2 | BS 10008 | Strength of Materials | 3 - 1 - 0 | 4 |
| 3 | | Introduction to Materials | 3 - 0 - 0 | 3 |
| 4 | BS 10004 | Programming and Data Structure | 3 - 1 - 3 | 6 |
| 5 | BS 10010 | Fundamentals of Biological Systems | 2 - 0 - 0 | 2 |
| 6 | BS 10010 | Workshop Lab | 0 - 0 - 3 | 2 |
| 7 | BS 19012 | Organic Chemistry Lab | 0 - 0 - 3 | 2 |
| 8 | BS 19009 | Electrical Systems Lab | 0 - 0 - 3 | 2 |
| 9 | EA 10002 | EAA – 2 | 0 - 0 - 0 | 0 |
| | | **Total** | **14 - 3 - 12** | **25** |

## Second Year

| Semester-III | | | | |
|---|---|---|---|---|
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 20001 | Transform Calculus, Probability & Statistics | 3-0-0 | 3 |
| 2 | BS 20007 | Numerical Methods | 1-0-3 | 3 |
| 3 | BS 20002 | Fluid Mechanics & Multiphase Flow | 3-1-0 | 4 |
| 4 | PE 20001 | Sedimentary & Petroleum Geology | 3-1-0 | 4 |
| 5 | PE 30003 | Drilling and Fracturing Technology | 3-1-0 | 4 |
| 6 | | Introduction to Petroleum Engineering | 2-0-0 | 2 |
| | | Fuel Lab | 0-0-3 | 2 |
| | EA 10003 | EAA III | 0-0-0 | 0 |
| | | **Total** | **15-3-9** | **24** |

| Semester-IV | | | | |
|---|---|---|---|---|
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 20006 | Advanced Statistical Techniques | 3-0-0 | 3 |
| 2 | PE 20007 | Elements of Reservoir Engineering | 3-1-0 | 4 |
| 3 | PE 30002 | Hydrocarbon Production Engineering- I | 3-1-0 | 4 |
| 4 | PE 20003 | Geomechanics | 3-1-0 | 4 |
| 5 | PE 20005 | Well Logging | 3-0-3 | 5 |
| 6 | | Surfactants | 2-0-0 | 2 |
| 7 | PE 20008 | Petroleum Geology Lab | 0-0-3 | 2 |
| 8 | EA 10004 | EAA IV | 0-0-0 | 0 |
| | | **Total** | **17-3-6** | **24** |

# Third Year

| Semester-V | | | | |
|---|---|---|---|---|
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 30001 | Industrial Psychology & Professional Ethics | 2-0-0 | 2 |
| 2 | PE 30011 | Advanced Reservoir Engineering | 3-1-0 | 4 |
| 3 | PE 30006 | Hydrocarbon Production Engineering II | 3-1-0 | 4 |
| 4 | PE 30007 | Advanced Drilling Technology | 3-0-0 | 3 |
| 5 | BS 20004 | Object Oriented Programming | 2-0-3 | 4 |
| 6 | PE 30004 | Drilling & Fracturing Lab | 0-0-3 | 2 |
| 7 | PE 20004 | Transport in Porous Media | 3-0-0 | 3 |
| | | **Total** | **16-2-6** | **22** |
| **Semester-VI** | | | | |
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | PE 30012 | Oil and Gas Well Testing | 3-0-0 | 3 |
| 2 | PE 40005 | Offshore and Deep sea technology | 3-0-0 | 3 |
| 3 | PE 40003 | Enhanced Oil Recovery | 3-0-0 | 3 |
| 4 | PE 30008 | Pipeline Engineering | 3-0-0 | 3 |
| 5 | | Elective I | 3-0-0 | 3 |
| 6 | BS 30003 | Economics | 2-0-0 | 2 |
| 7 | PE 30009 | Reservoir Engineering Lab | 0-0-3 | 2 |
| 8 | PE 40002 | Production Engineering Lab | 0-0-3 | 2 |
| | | **Total** | **17-0-6** | **21** |

# Fourth Year

| Semester-VII | | | | |
|---|---|---|---|---|
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | PE 40008 | Health Safety and Environment (HSE) | 2-0-0 | 2 |
| 2 | PE 40001 | Reservoir Simulation | 3-1-0 | 4 |
| 3 | | Elective II | 3-0-0 | 3 |
| 4 | BS 40002 | Data Analytics and AI for Process Industry | 3-0-0 | 3 |
| 5 | CH 40001 | Project Engineering and Management | 3-0-0 | 3 |
| | | Innovation Lab | 0-0-3 | 2 |
| 6 | BS 48001 | Industrial Training | 0-0-0 | 2 |
| 7 | BS 47001 | Project I | 0-0-6 | 4 |
| | | **Total** | **14-1-9** | **23** |
| **Semester-VIII** | | | | |
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | | Elective III | 3-0-0 | 3 |
| 2 | | Elective IV | 3-0-0 | 3 |
| 3 | | Elective V | 2-0-0 | 2 |
| 4 | PE 40004 | Reservoir Simulation Lab | 0-0-3 | 2 |
| 5 | BS 47002 | Project II | 0-0-9 | 6 |
| 6 | BS 48002 | Comprehensive Viva-Voce | 0-0-0 | 2 |
| | | **Total** | **8-0-12** | **18** |

**Appropriate certifications as per NEP 2020** (Source: Point no. 11.9 of National Education Policy 2020)

1st Year Exit: **Certificate**

2nd Year Exit: **Diploma**

3rd Year Exit: **Bachelor ’s Degree**

4th Year Exit: **Degree with Research**

**Draft Syllabus**

**for 3rd Year and 4th Year Mechanical Engineering B-Tech Program**

## Semester-V

### Industrial Psychology & Professional Ethics

Understanding human experience and behavior: Definition, schools, methods, branches and application of Psychology for Engineers. Basic Psychological Processes: Intelligence, Thinking, Attention, Learning, Motivation and Emotion: Theories, Motivating people at Workplace, Personality: Definition, Approaches and Theories. Nature and Meaning of Industrial Psychology, Role of Industrial, Psychology, Organizational Attitude, Industrial Psychology and Organizational Behaviour: Concepts, Hawthorne Studies, Application, Personnel Selection, Job satisfaction Leadership and Management, Professional Ethics, Functions of organizational culture, Organizational, Forces for change in Organization, Resistance to change, Lewin's Change Model

***Source: IIPE/ common subject for PE, CE and ME students***

### Design of Machine elements

Principles of mechanical design: Strength, Rigidity, Fracture, Wear, Material considerations, Standardization, Limits and Fits. Factor of safety. Stress concentrations. Design for static and fatigue strength. Design of shafts, axles, keys, riveted joints, bolted joints, welded joints, springs, brakes and clutches. Couplings and power screws.

Design of Gears; Lubrication and Wear consideration in Design; Design and selection of Bearings: Hydrodynamic lubrication theory, Hydrostatic and Hydrodynamic bearings (e.g., journal), Rolling Element Bearings; Systems Approach to Design: Decision Making, Simulation of mechanical systems using CAD tools, Sensitivity analysis of design parameters, Value Analysis and Value Addition to designed components and systems; Exercises of mechanical systems design with examples; Overview of Optimization in Design; Reliability and Robust Design; Communicating the Design.

### Advance Mechanics of Solids

Introduction of theory of elasticity- Analysis of Stress and Strain, Stress equation of equilibrium, Compatibility equations, Stress-Strain Relations, Solution of elasticity equations-stress function approach. Theories of failure- Yield criteria. Energy methods- Generalized forces and displacements, Reciprocal Theorem, Maxwell-Betti-Raleigh reciprocal theorem, Castiglianoâs theorems, Theorem of virtual work. Bending of Beams Straight and asymmetrical bending, Shear center, bending of curved beams, Deflection of thick curved beams. Axisymmetric problems- Thick walled cylinders subjected to internal and external pressures-Lameâs equation, Stresses in composite Tubes-Shrink fits, rotating discs with

uniform and variable thickness, Rotating shafts and cylinders. Columns and struts- Euler's Buckling load, Different end conditions, Beam columns, Energy methods in buckling problems

**I.C Engines and Gas Turbines**

Introduction to I.C Engine-Classification-Components-Air standard cycles, characteristics of fuel air mixtures, variation of specific Heats-Actual cycles, actual processes taking place in Engines-Importance of Port, Valve timing diagram Carburetion and fuel injection: Requirements of a good carburettor, simple carburettor, complete carburettor, Calculation of air-fuel ratio for a simple carburettor. Electronic fuel injection in S.I. engine. Requirements of diesel injection system, types of injection systems, fuel pumps. Ignition systems Combustion in S.I. Engine and C.I. Engines: Stages of combustion in S.I. Engine, Detonation, Control of detonation. Stages of combustion in C.I. Engines, delay period, factors Various systems of I.C. Engine, Lubrication system, function of lubricating system. Cooling system etc. Testing and performance: Variable speed test of S.I. Engine, Constant speed load tests of C.I. Engines Morse tests Engine Emissions-Pollutants and their ill effects, pollutants from Gasoline and diesel. Supercharging and turbo charging. Gas Turbines: Brayton cycle Components of a gas turbine plant open and closed types of gas turbine plants Optimum pressure ratio Improvements of the basic gas turbine cycle multi stage compression with inter-cooling multi stage expansion with reheating between stages exhaust gas heat exchanger, Applications of gas turbines.

V. Ganesan, Internal Combustion Engines, TMH Publishers

V. Ganesan, Gas Turbines, TMH Publishers

**Machining and Machine tool operation**

Machine tools: Concept and definition of machining and machine tools. Concept of producing geometrical surfaces by generatrix and directrix. Kinematic systems and structures of conventional machine tools. Electromechanical and hydraulic drives and control of machine tools. Machine tool automation. Classification and specification of machine tools. Construction, working principle and application of various semi-automatic and automatic lathes. Flexible automation, principle and advantages. Basic constructional features, working principle and application of CNC machine tools, machining centre and FMS. Machining: Tool geometry, mechanism of chip formation. Mechanics of machining. Cutting temperature, causes, effects, estimation, measurement and control. Cutting fluid applications. Failure modes, wear and life of cutting tools. Cutting tool materials. Role of geometrical and process parameters and cutting fluid on machinability. Mechanics of grinding. Economy of machining and grinding. Special techniques and advanced technology of machining and grinding.

**Systems and Control**

Introduction to System Dynamics, Feedback and Feed-forward control, Model-based control, Lagrange's equations, Hamilton's principle, State space form, Port Hamiltonian systems, Multi-energy domain systems, Lumped parameter models, Bond graph modelling, Transducers, Active and passive interfaces, Concept of physical and computational causality, generation of state space equations from bond graph model for linear and non-linear systems,

algebraic, causal and differential-algebraic loops, concept of activated bonds, sensors and actuators. Linearization, Model order reduction, Equivalence of systems, Transformer and gyrator equivalence, Model scaling, modelling of systems with two-force members, constraints and degrees of freedom, relaxed constraints, joints with clearance/flexibility, modelling planar multi-body mechanisms, robot manipulators and other systems. Active and passive control, Modelling of active electro-mechanical and mechatronic systems, Block diagram representation of causal linear and non-linear models, introduction to MATLAB-Simulink. Recall of Laplace transform, Definition of transfer function, System identification in the frequency domain, Time response to step, impulse and sinusoidal inputs, Response characteristics, transfer function from state space model, Signal flow graph for LTI systems, Masson's gain rule and transfer function generation. Stability of LTI systems, Steady state error, PID control and controller tuning, Routh-Hurwitz criterion, Absolute versus relative stability, Root loci technique, PI controller design, Lead and Lag compensator circuit design using root loci, Use of Op-amps as buffer, Nyquist plot and stability, Gain and phase margins, Lead and lag compensator circuit design using Nyquist plot, Phase minimal property, Passivity and robustness, M and N circles. Brief description on the concepts of controllability and observability, pole placement, sampling theorem, digital and optimal control, multi-variate and non-linear control, and fault tolerant control (just description).

**Heat Transfer Lab**

- Heat transfer in a pin fin under forced convection heat transfer mode
- Heat transfer from the extended surface relies on natural convection and radiation.
- Emissivity measurement
- Natural convection heat transfers for a vertical tube
- Pool boiling phenomenon up to critical heat flux point
- Unsteady state conduction of heat

**Workshop II**

Machine Tools and Machining: Machine Tool: Acceptance test of machine tool (radial drilling machine) System compliance of machine tool (center lathe) Machine setting and operation for helical gear teeth cutting Machining: Sharpening of turning tool to specific geometry Measurement of cutting forces and surface finish in turning, drilling and milling Measurement of cutting temperature and tool life in turning Measurement of grinding forces and surface finish in grinding. Metrology: Inspection of straightness and flatness of surfaces Measurement of angles Measurement of external and internal taper Inspection of screw threads Inspection of gear teeth Measurement of roundness by Elrond Calibration of measuring instruments. Casting, Welding TIG/MIG welding, Forming

## Semester-V

**Applied Thermofluids**

Basic concept of Refrigeration and Air conditioning, various refrigeration cycles such as: Vapour absorption and compression cycles, Refrigeration systems.

Fuels and their properties, stoichiometric and actual air requirements, flue gas analysis, boiler energy balance, draft system. Different types of furnaces for burning coal, fuel oil and gas. Circulation theory, down-comers and risers, economizers and super heaters, air pre-heater, drum and its internals.

Different types of boilers, boiler mountings, feed water treatment, boiler loading and manner of operation. Optimization of reheat pressure and degree of regeneration, coupled cycles and combined plants, process heat and power.

Steam turbines; convergent and convergent-divergent nozzles - theory and design. Impulse and reaction turbines, compounding of turbines, optimum velocity ratio, reheat factor and condition line, parallel exhaust, losses in steam turbines, steam turbine governing. Theory and design of condensers, air ejector and cooling tower.

**Industrial Engineer and Management: Will be Updated later!**

Elective- I

**Economics**

Introduction, Demand and Supply Analysis, Production and Cost, Price Output Determination, Capital Market and Investment Decisions, Outline of Welfare Economics, Resource Accounting and Sustainability, Income Determination and Fluctuations, Trade, Aid and Development. Economic Systems & Indian Economic Policies. Break Even Analysis, Financial measures and profitability analysis; Risk, uncertainty, and decision analysis; Implications of fiscal and trade policies and regulations for industry Economics.

**Machine Design Practice**

Design Calculation and Drawings of the followings.

Assignment 1: Generation of geometric profiles of gears and cams. ( 3hrs x 2) Assignment 2: Dimensioning concept and detail drawing of machine components. (3hrs) Assignment 3: Design and drawing of a gear box (3hrsx4 to 5) Assignment 4: Design and Drawing of Brake or Clutch (3hrs. x 2) Assignment 5: Design of a pressure vessel/engine head (Mainly bolt joints) (3hrs)

**Fluid Machines Lab**

- Performance testing of water turbines: Pelton, Kaplan, Francis
- Performance testing of reciprocating and centrifugal pumps
- Performance test of a two stage Reciprocating Air Compressor
- Performance test of a two stage axial Air Compressor
- Performance test on an Air Blower.

**Semester-VII**

**Elective II**

**Optimization Techniques:**

Development, definition, characteristics and phases, types of optimization models, applications; Allocation: linear programming, problem formulation, graphical solution, simplex method, artificial variables techniques, two–phase method, Big-M method.

Transportation problem: Formulation, optimal solution, unbalanced transportation problem, Degeneracy; Assignment problem, formulation, optimal solution, variants of assignment problem, traveling salesman problem

Sequencing and Replacement Sequencing: Introduction, flow, shop sequencing, n jobs through two machines, n jobs through three machines, job shop sequencing, and two jobs through "m" machines. Replacement: Introduction: Replacement of items that deteriorate with time, when money value is not counted and counted, replacement of items that fail completely, group replacement.

Theory of Games and Inventory Theory of Games: Introduction – Terminology, Solution of games with saddle points and without saddle points, 2×2 games, dominance principle, m X 2 & 2 X n games, Graphical method. Inventory: Introduction, Single item, Deterministic models, Purchase inventory models with one price break and multiple price breaks, Stochastic models, demand may be discrete variable or continuous variable, Single period model and no setup cost.

Waiting Lines, Dynamic Programmimg and Simulation Classes: 09 Waiting Lines: Introduction, Terminology, Single Channel, Poisson arrivals and exponential service times with infinite population and finite population models, Multichannel, Poisson arrivals and exponential service times with infinite population. Dynamic Programming: Introduction, Terminology, Bellman's Principle of optimality, Applications of dynamic programming, shortest path problem, linear programming problem. Simulation: Introduction, Definition, types of simulation models, steps involved in the simulation process - Advantages and Disadvantages, Application of Simulation to queuing and inventory.

**Data Analytics and AI**

Introduction: Introduction to Data Analytics and Artificial Intelligence- Some illustrations of AI Problems-Data-Information-Knowledge-Applications of Data Analytics-Introduction to the Languages of Data Science: R, SQL, and Python. Data warehousing: Introduction to Data warehousing, Concepts of Data warehousing-OLAP-Data Preparation and Visualization. Descriptive Statistics: Central Tendency and Variability, Inferential Statistics-Probability-Central Limit Theorem-Exploratory Data Analysis-Hypothesis Testing-Linear Regression. Classification: KNN, Naïve Bayes and Logistic Regression-K-means and Hierarchical Clustering-Decision Trees-Support Vector Machines-Neural Networks-Association Rule Mining.

**Project Engineering and Management**

Stages of Project Implementation; Project Milestone: Planning, Analysis, Selection, Implementation; Generation and Screening of project ideas. Feasibility studies. Project Analysis and introduction to various component of Project cost and their estimation; Elements of Coat of Project, Cost of Production; Financing of projects: Debt-Equity ratio etc... Depreciation concept, Capital cost estimation, Working capital estimation, Project Evaluation, break-even analysis, ROI, IRR., Discounted cash flow analysis. Project Management and Scheduling, Network Technique for project management: CPM and PERT, Project Risk Assessment, Social Cost benefit analysis, Venture capital and Private Equity.

**Industrial Safety:**

Introduction to Engineering safety, Sources of hazards in various engineering systems, e.g. mines, chemical industries, nuclear industries, offshore platform, automotive, etc. Prevention through design (PtD) Hazard identification, quantitative risk assessment, and risk control systems, Integrated safety management, Human factors and safety, Industry and safety considerations, Role of safety analytics, Safety economics, safety acts, rules and regulations

**Thermofluids lab**

Experimental observations on a refrigeration test-rig. Performance evaluation of a vapour compression refrigeration system. Pull-down and cycling studies on a cold storage unit. Performance evaluation of an air conditioning system Pressure distribution for flow over a cylinder, measurement of velocity profile in the boundary layer, characteristics of a convergent divergent nozzle and characteristics of a centrifugal fan**.**

Determination of heat transfer coefficient in fluidized bed combustion, Pressure drop and holdup studies for a fluidized bed, Determination of flame velocity and burner loading in premixed combustion of gaseous fuel and Determination of boiler efficiency and condenser heat transfer coefficient of electrical boiler.

## Semester-VIII

**Computer Aided Design and Manufacturing**

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformation homogeneous coordinates – Line drawing -Clipping- viewing Transformation- Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM –CAD/CAM concepts —Types of production – Manufacturing models and Metrics – Mathematical models of Production Performance

Geometric Modelling: Representation of curves- Hermit curve- Bezier curve- B-spline curves- rational Curves-Techniques for surface modelling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modelling techniques- CSG and B-rep

Standards for computer graphics- Graphical Kernel System (GKS) – standards for exchange images- Open Graphics Library (OpenGL) – Data exchange standards – IGES, STEP, CALS etc. – communication standards

Automation and mechanization, Numerical Control of machine tools, different types of controls, point to point, continuous path, digital and analog control, absolute and relative, NC system devices, Direct numerical control (DNC) and computer numerical control (CNC), adaptive control of manufacturing processes, Computer-process interface, CNC, programming, introduction to FMS, CIM, Robotics, AGV, CMM, Rapid Prototyping and Rapid

Reference:

1. CAD/CAM Theory and Practice, Ibrahim Zeid, Tata McGraw Hill Publication

2. CAD/CAM Principle and Application, P. N. Rao, Tata McGrawHill Publication.

3. users guides to Rapid Prototyping, Todd Frimm, Society of Manufacturing Engineers

4. Computer control of Manufacturing system, Yoramkoren, McGraw Hill Publication.

5. Machining and Metal Working Handbook, Ronal A Walsh and Denis Cormier McGraw Hill Publication.

6. Machining and CNC Technology, M. Fitzpatrick, McGraw-Hill Publication.

7. Journey from Rapid Prototyping to Rapid Manufacturing, S Chattopadhyaya, Lambert Publication.

# ELECTIVES

**Elective I&II**

**Power plant engineering:**

Steam Power Plants: Classification of boilers, essentials of a good boiler, high pressure boilers, difference between sub-critical and super critical boiler, boiler mountings, boiler efficiency, methods of water treatment, steam nozzles and steam turbines, condensers, cooling pond and cooling towers and governing systems; Ash handling systems, Dust collection and controlling methods, Soot blowers; Fuels and fuel handling, Combustion of fuels.

Gas Turbine Power Plant: Selection of plant, Components, Layout and site selection of plant, Gas turbine fuels, gas turbine cycles, comparison with other power plants, Advantages and disadvantages.

Diesel Engine Power Plants: Auxiliary equipment, supercharging and turbo charging, limitations of supercharging, waste heat recovery, comparison with other plants, Selection and location of nuclear power plant.

Nuclear Power Plants: Selection and location of nuclear power plant, Fusion and Fission principle, classifications of reactors, nuclear materials and waste disposal, Effect of nuclear radiation and safety aspects.

Hydraulic Power Plants: Location of plant, Classification, Essential elements and layout of the plant, Selection of turbine.

Solar Energy Power Plants: Types of solar collectors, performance analysis of solar collectors.

Combined Cycle Power Generation: Binary Vapour cycles, Coupled cycles, Combined cycles, Gas turbine – steam, MHD – steam and thermionic – steam power plants.

Economics of Power Plants: Fixed cost, operating or running costs, economic factor, load curves, cost of generating station, energy rates.

References:

1. Power Plant Engineering – Nag, P.K.

2. Power Plant Engineering – Dr. P.C.Sharma

3. Steam & Gas Turbines and Power Plant Engineering – Yadav, R.

4. Steam Turbine Theory and Practices – Kearton, W.J.

5. Steam and Gas Turbines, Stodola, A.

**Tribology**

Tribological Elements – Sliding Bearing – Journal Bearings – Rolling contact bearing – Piston, piston ring liner etc.

Types of wear and their Mechanism – Wear in lubricated contact – Film lubrication

Elements of contact Mechanics – Thermal effects in surface contact – Contact between rough surface

Friction Lubrication wear in Clutch, Brake, Pneumatic Tyre, Mechanical Seal, drives etc.

Sliding Bearing – Thrust bearing – Journal Bearing – Application - selection – modern developments

Rolling Contact Bearing, Materials of Bearings, Trouble-shooting Bearing Problem

Reference

1. Tribology in machine design -- By --T. A. Stolarski

2. Tribology & design edited by M. Hadfield, C. A. Brebbia, J. Seabra

3. Tribological Design of Machine Elements by D. Dowson , C.M. Taylor, M. Godet, D. Berthe

**Rapid Prototyping:**

Introduction to RP processes, applications, benefits, limitations, comparison between RP processes and CNC Machining. Different Rapid Prototyping Processes –

namely Stereolithographic (STL), Laser Sintering; Fused Deposition Modelling (FDM), Solid Ground Curing (SGC); Laminated Object Manufacturing (LOM), Ballistic Particle Manufacturing (BPM), Three Dimensional Printing (3DP), numerical Examples. Materials of

RP Technology - Photo Sensitive Resin, Wax etc. Manufacturing processes to be interfaced with RP Techniques - Investment Casting, Vacuum Casting, Laser Additive Manufacturing. Rapid manufacturing processes like - Vacuum Casting Processes via RP Processes, Electroplated Prototypes, RTV Silicon Moulds, Direct Inkjet SL Tooling, Electron Beam Melting

References

1. Rapid Manufacturing: An Industrial Revolution for the Digital Age. Neil Hopkinson, Richard Hague, Philip Dickens (Editors); Wiley; Jan., 2006; ISBN:10: 0470016132; 13: 978-0470016138.

2. Additive Manufacturing Technologies; Rapid Prototyping to Direct Digital Manufacturing. Ian Gibson, David W. Rosen, Brent Stucker; Springer; January, 2010; ISBN: 978-1-4419-1119-3.

3. Rapid Prototyping: Principles and Applications. Rafiq I. Noorani; Wiley; Oct., 2005; ISBN: 10: 0471730017; 13: 978-0471730019.

4. User's Guide to Rapid Prototyping. Todd Grimm; Society of Manufacturing Engineers; February, 2004; ISBN: 0-87263-697-6.

5. Rapid Prototyping - Laser-based and Other Technologies. Patri K. Venuvinod and Weiyin Ma; Kluwer Academic Publishers; October, 2003; ISBN: 1-4020-7577-4.

6. Rapid Prototyping. Andreas Gebhardt; Hanser Gardner Publications; 1st ed., June 1, 2003; (Originally published in German, 1995); ISBN: 156990281X.

7. Rapid Prototyping: Principles and Applications (2nd Edition). Chua Chee Kai, Leong Kah Fai, Lim Chu-Sing; World Scientific Pub Co; March, 2003; ISBN: 9812381171.

8. Rapid Prototyping: Theory and Practice. Ali Kamrani, EmadAbouel Nasr (Editors); Springer; 1st ed., Jan., 2006; ISBN:10: 0387232907; 13: 978-0387232904.

9. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov

**Composite Materials:**

Introduction to composites: Basic concepts, Structural applications, Classification, Strength and stiffness advantages, Manufacturing aspects of composites.

Micro-mechanics: Mechanics of materials method, Bounding methods, Semiemperical methods, Longitudinal and Transverse elastic properties, Inplane Shear modulus, Stress – strain relations for General anisotropic, Especially orthotropic and Transversely isotropic Materials, 2D Transformation of Stress – strain, Elastic parameters, Engineering constants, 3D Transformation of Stress – strain, and Elastic parameters.

Macro-mechanics: Strength analysis of Unidirectional Lamina under various loading conditions, Failure theories, Computational procedure for determination of Lamina strength – Tsai – Wu criterion.

Elastic behaviour of Multidirectional laminates – symmetric and asymmetric laminates, Computational procedure for determination of engineering elastic properties, Carpet plots for multidirectional laminates.

Stress and failure analysis of multidirectional laminates, Hydrothermal effects, Experimental methods for characterization and testing of Composite materials. design of laminates.

References:

1. Mechanics of composite materials, R. M. Jones, 2ndEdn. Taylor& Francis, 1999.

2. Engineering mechanics of composite materials, I. M. Daniel & O. Ishai, 2ndEdn., Oxford University Press, 2006.

3. Principles of composite material mechanics, R. F. Gibson, 2ndEdn. CRC Press, 2007

**Mechatronics**

Introduction to Mechatronics: Definition, Comparison between traditional and mechatronic approach, Microprocessor-Based Controllers and Microelectronics.

Electronics: Review of fundamentals of electronics, Operational amplifiers, Digital circuits, sensors, transducers, electrical contacts, actuators, signal processing devices.

Drives: Stepper motors, servo drives.

Control Systems: Open loop and closed loop control, Time domain and state space analysis of control systems, Mathematical modelling of physical systems: Liquid-level, pneumatic and hydraulic systems; PI, PD and PID controllers; Routh's criteria, Root locus analysis, Bode plot and Nyquist plot; Introduction to discrete-time systems and Z-transform; A/D and D/A Conversion.

Microprocessor: Introduction to 8085/8080A Microprocessor architecture and programming

References:

1. Automatic Control Engineering by F.H. Raven, McGraw-Hill International.

2. Modern Control Engineering by K. Ogata, Prentice Hall.

3. Automatic Control Systems by B.C. Kuo, Prentice Hall.

4. Mechatronics, HMT Ltd., TMH.

5. Introduction to Mechatronics and Measurement Systems by David G. Alciatore and Michael B. Histand, TMH

6. Mechatronics: Integrated technologies for Intelligent Machines by A. Smaili and F. Mrad, Oxford Higher Education

7. Microprocessor Architecture, Programming and Applications with the 8085/8080A by R.S. Gaonkar, Wiley Eastern Ltd.

**Robotics**

Introduction: Robot definition, robot anatomy; robot classifications and specifications.

Actuators: Pneumatic, hydraulic, electrical drives and controls.

Robot end-effectors: mechanical, magnetic and vacuum grippers.

Sensors, robot vision and signal conditioning.

Robot kinematics: forward and inverse transformation, homogeneous transformations, link velocity and acceleration analysis: Jacobian matrix.

Statics and manipulator design: Recursive calculations, equivalent joint torques.

Dynamics: Euler-Lagrange formulation, Newton-Euler formulation, recursive robot

dynamics- forward and inverse.

Linear Control: Transfer function and state-space representation of a robotic joint, performance and stability of feedback control, P, PI, PD and PID control, state-feedback control, joint controllers.

Case study: practicing code writing (MATLAB) for forward and inverse dynamics of serial chain robotic manipulator.

References:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, Prentice Hall

2. Mark W. Spong, Robot Modeling and Control, Wiley

3. S. K. Saha, Introduction to Robotics, McGraw Hill

4. S.R. Deb, Robotics Technology and Flexible Automation, McGraw Hill

5. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill International Editions

**Automobile engineering:**

Introduction: Basic structure, general layout and type of automotive vehicles, Frameless and unitary construction; position of power unit.

Power Unit: Power requirements - motion resistance and power loss, tractive effort and vehicle

performance curves; selection of power unit and engine performance characteristics; pollution due to vehicle emission and exhaust emission control system.

Chassis and Suspension: Loads on the frame, considerations of strength and stiffness, different types of chassis and their construction; engine mounting on the chassis, Need of Suspension System, Types of Suspension; factors influencing ride comfort, conventional and independent suspension systems; shock absorbs and stabilizers; wheels and tyres.

Transmission system: Basic requirements and standard transmission systems; constructional features of automobile clutch, gear box, differential, front and rear axles; overdrives, propeller shaft, universal joint and torque tube drive; Rear wheel vs front wheel

drive, principle of automatic transmission.

Steering System: Requirement and steering geometry; castor action, camber and king pin angle, toe-in of front wheels, steering linkages and steering gears; wheel alignment; power steering.

Braking System: General braking requirements; Mechanical, hydraulic, vacuum power and servo brakes; Weight transfer during braking and stopping distances.

Electric System: Conventional (coil and magneto) and transistorized ignition systems; Charging, capacity ratings and battery testing; starter motor and drive arrangements: voltage and current regulation; lighting and accessory systems.

Safety and comfort systems

Maintenance: Preventive maintenance, trouble shooting and rectification in different systems; engine tuning and servicing

References:

1. A Textbook of Automobile Engineering – R. K. Rajput, Laxmi Publ. (P) Ltd.

2. Automotive Mechanics – W. H. Crouse & D. Anglin, Tata McGraw Hill

3. Automobile Engg. (Vol. 1 & 2) – K. M. Gupta, Umesh Publications

4. Automobile Engineering – K M Moeed, S K Kataria& Sons

**Finite Element Analysis:**

Principles of variation calculus.

Methods of Finite element analysis: stiffness method, potential energy and Rayleigh-Ritz method, Galerkin FE formulation, element formulation, and coordinate transformation, isoparametric formulation.

Applications: problems of structural mechanics and solid mechanics. Plane stress & plane stress problems, 3-D problems. Torsion, bending of plates and shells. FE formulations for vibrations, heat transfer and fluid flow problems.

Associated flowcharts and computer programming.

References:

1. Introduction to Finite Elements in Engineering, T. R. Chandrupatla& A. D. Belegundu, 2nd Ed., PHI, 2001.

2. An Introduction to the Finite Element Method, Reddy, J. N., 2005.

3. The Finite Element Method, O. C. Zienkiewicz, 3rd Ed., McGraw-Hill, 1997.

4. The Finite Element Method in Engineering, S. S. Rao, 2nd Ed., Elmsford, Pergamon, 1989.

5. Introduction to the Finite Element Method: A Numerical Method for Engineering Analysis, Desai, C. S. and Abel, J. F., 1972

**System modelling and simulation**

Introduction, Power variables, constitutive laws, physical system coordinates.

The notion of causality, generation of system equations.

Dynamics of rigid bodies, modelling in non-inertial coordinates, modelling of Physical systems:

Electrical systems, mechanical systems, structural members, thermal systems, and hydraulic systems.

Art of creating system bond graph, application of bond graphs to control systems, signal flow graph. Simulation with software.

References:

1. Karnopp, D. C. Rosenberg, R.C. and Margolis, D.L. "System Dynamics: A Unified Approach"

John-Wiley and Sons Inc., 1990.

2. Mukherjee, A., Karmakar, R. and Samantaray, A.K. Bond Graph in Modeling, Simulation and

Fault Identification. I. K. International: New Delhi, India, ISBN 81-88237-96-5, 2006

**Computational Fluid Dynamics**

Introduction to Computational Fluid Dynamics and Principles of Conservation: Continuity Equation, Navier Stokes Equation, Energy Equation and General Structure of Conservation Equations, Classification of Partial Differential Equations and Physical Behaviour, Approximate Solutions of Differential Equations: Error Minimization Principles, Variational Principles and Weighted Residual Approach, Fundamentals of Discretization: Finite Element Method, Finite Difference and Finite Volume Method, Finite Volume Method: Some

Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems, Boundary Condition Implementation and Discretization of Unsteady State Problems, Important Consequences of Discretization of Time Dependent Diffusion Type Problems and Stability Analysis : Consistency, Stability and Convergence, LAX Equivalence theorem, Grid independent and time independent study, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): FTCS (Forward time central space) scheme, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): CTCS scheme (Leap frog scheme), Dufort-Frankel scheme, Stability analysis of hyperbolic equations: FTCS, FTFS, FTBS and CTCS Schemes, Finite Volume Discretization of 2-D unsteady State Diffusion type Problems, Solution of Systems of Linear Algebraic Equations: Elimination Methods, Iterative Methods, Gradient Search Methods, Discretization of Convection-Diffusion Equations: A Finite Volume Approach, Discretization of Navier Stokes Equations: Stream FunctionVorticity approach and Primitive variable approach, SIMPLE Algorithm, SIMPLER Algorithm, Unstructured Grid Formulation , Introduction to Turbulence Modelling.

**Mechanical Vibrations**

Fundamental Aspects of Vibrations: Vibration, main causes, advantages and disadvantages; engineering applications of vibration and noise; vector method of representing harmonic motion; characteristics of vibration, harmonic analysis and beats phenomenon, work done by harmonic forces on harmonic motion; periodic, non-harmonic functions- Fourier series analysis; evaluation of coefficients of Fourier series; elements of vibratory system; lumped and distributed parameter systems. Undamped Free Vibrations: Derivation of differential equation of motion: the energy method, the method based on Newton's second law of motion, and Rayleigh's method. Solution of differential equation of motion: Natural frequency of vibration. Systems involving angular oscillations: the compound pendulum. Damped Free Vibrations: Viscous damping: coefficient of damping; damping ratio; under damped, over damped and critically damped systems; logarithmic decrement; frequency of damped free vibration; Coulomb or dry friction damping; frequency, decay rate and comparison of viscous and Coulomb damping; solid and structural damping; slip or interfacial damping.

Harmonically excited Vibration: One degree of freedom- forced harmonic vibration; vector representation of forces; excitation due to rotating and reciprocating unbalance; vibration Isolation, force and motion transmissibility; absolute and relative motion of mass (Seismic Instruments). Whirling Motion and Critical Speed: Whirling motion and Critical speed: Definitions and significance. Critical - speed of a vertical. Critical speed of a shaft carrying multiple discs (without damping), Secondary critical speed.

Systems with Two Degrees of Freedom: Principal modes of vibration; torsion vibrations; Forced, Un-damped vibrations with harmonic excitation; Coordinate coupling; Dynamic vibration absorber; torsion Vibration Absorber; Pendulum type of dynamic vibration.

**Refrigeration and air conditioning**

Introduction about Refrigeration – Definitions of various terms. Methods of refrigeration. Air refrigeration system. Bell – Coleman cycle. Introduction about Air Craft Air-conditioning.

Analysis of Vapour compression cycle, Modifications to basic cycle. Multi pressure systems. Multi-evaporator system and Cascade systems. Properties of refrigerants. Selection of refrigerants. Discussion of components of V.C system, Servicing. Vacuuming and charging of refrigerant. Introduction to cryogenics. Psychometric – Definitions for properties. Introduction to cooling load calculations. Comfort conditions. Effective temperature concept. Air-conditioning systems – discussion about the central plant with direct evaporator and chiller applications, Ice plant, refrigerators. Food preservation, IQF technique and freeze drying etc. Cold storage and thermal insulation.

**Elective-III**

**Subject: Bio energy**

Overview of Global and Indian energy scenario

Sources of Energy and its classifications

Renewable energy sources, classification and systems

Overview of 1st, 2nd and 3rd law of thermodynamics

Thermodynamic processes and basic cycles

Introduction to Bioenergy; Current status, merits & demerits.

Feedstock: starch, oilseed, lignocellulosic and algae based, fuel logistics of Biomass, Biological conversion technologies, enzyme hydrolysis, ethanol fermentation, comparisons of fossil fuels and bio fuels,

Fundamentals of anaerobic digestion, Microbial fuel cells, Bio-refinery,

Economic, Social and Ecological Impacts of Bioenergy at Local, National and Global Levels, Life cycle assessment, current and emerging challenges to bioenergy development, Govt policies and standards.

Text Books:

1. Y. Li, and S. K. Khanal, Bio Energy: Principles & Applications: Wiley-Blackwell 2016.

2. S. Lee, and Y T Shah, Bio Fuels and Bio Energy: Processes and Technologies, CRC Press, 2012

**Solar & Photovoltaic energy**

Overview of Global and Indian energy scenario

Sources of Energy and its classifications

Renewable energy sources, classification and systems

Overview of 1st , 2nd and 3rd law of thermodynamics

Thermodynamic processes and basic cycles

Nature and availability of solar energy; Principle of operation of solar cells – materials and processing, thin film, unconventional materials and systems;

Concentrators; Cells and system characteristics; Power conditioning, energy storage, and grid connection;

Maximum power point tracking, PV to grid – single and three phases; Economy and Life cycle costing.

Solar thermal energy. Water pumping: dc and ac pump drive; Peltier refrigeration.

Text/Reference Books:

1. Hans S. Rauschenbach, Solar Cell Array Design Handbook: The Principles and Technology of Photovoltaic Energy Conversion. Springer (2013).

2. C. Hu and R.M. White, Solar Cells: From Basic to Advanced Systems. McGraw Hill (1983)

**Nuclear, Wind & Geothermal energy**

Overview of Global and Indian energy scenario

Sources of Energy and its classifications

Renewable energy sources, classification and systems

Overview of 1st, 2nd and 3rd law of thermodynamics

Thermodynamic processes and basic cycles

Nuclear:

Basic nuclear models, radioactivity, nuclear reactions – energy systems based on fission & fusion reactions; Reactor heat generations and removal; Nuclear Fuel cycle from Uranium / Thorium supply, enrichment, fuel management and waste disposal; Interaction of ionizing radiation with matter, radiation detection, shielding, and effects on human health.

Wind:

Introduction to wind resources: wind speed and terrain properties, power density; Measurement of wind speed and turbulence; Wind turbine / rotor design: Thrust, torque, speed, and power; Turbine material design and structural analysis; Integration of variable power production into electrical systems: Control of rotor speed, maximum power in low wind speeds, constant power in high wind speeds; Offshore wind farm: Dynamic wind and wave loadings, grid integration, operational and maintenance strategies; Cost of energy from wind turbine during lifetime.

Geothermal:

Nature, occurrence, types and classification of geothermal fields; Basics of geothermal exploration, drilling and production, and conversion methods;

Analysis of energy system proposals with reference to engineering, economic, socio-political, and environmental objectives.

Text/Reference Books:

1. James F. Manwell, Jon G. McGowan, Anthony L. Rogers, Wind Energy Explained: Theory, Design and Application. Wiley-Blackwell (2009).

2. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, Wind Energy Handbook. Wiley (2001). 3. Arnold Watson, Geothermal Engineering: Fundamentals and Applications. Springer (2014).

4. J.R. Lamarsh, A.J. Baratta, Introduction to Nuclear Engineering. Pearson Education India (2014).

5. Robert E. Masterson, Nuclear Engineering Fundamentals: A Practical Perspective. CRC Press (2017)

**Energy Conversion**

Overview of Global and Indian energy scenario

Sources of Energy and its classifications

Renewable energy sources, classification and systems

Overview of 1st , 2nd and 3rd law of thermodynamics

Thermodynamic processes and basic cycles

Hydro power:

Fundamentals of Mini/micro-hydel systems.

Non- conventional method of energy conversion:

Magneto hydrodynamics (MHD)

Thermoelectric generator

Thermionic generator

Thermos nuclear fusion

Wave energy conversion

Ocean thermal energy conversion

Fuel cell: importance, classification, basic principle design, materials used for developing fuel cells, applications and future prospects

Text/Reference Books:

Nag P.K., Thermodynamics (1996), Tata McGraw Hill

Garg H. P. and Prakash S. (1997); Solar Energy: Fundamental and Application, Tata McGraw Hill

Mohammad Omar Abdullah (2012); Applied Energy: An Introduction, CRC Press

B H Khan (2014); Non-Conventional Energy Resources, 2nd Edition, McGraw Hill Education

Solanki C. S. (2009); Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice Hall India •Nag P.K., Power Plant Engineering (2002), Tata McGraw Hill Education.

Source: IIT GUWAHATHI (rearranged from M.Tech Energy engineering syllabus) & IIPE

**Elective –IV**

**Supply Chain Management**

Introduction to Modelling and Analytics in Supply Networks

Supplier Selection Analytics

Transportation Modelling and Analytics

Warehousing Modelling and Analytics

Strategic Performance Improvement

Inventory Analytics – I

Inventory Analytics – II

Inventory Analytics – III

Inventory Analytics – IV

Modelling Coordination in Supply Chains

Risk Analytics in Supply Network Design

Design and Modelling the global supply chain

**Quality Control & Management**

Introduction to Quality Control and Improvement, Quality Control Tools

Statistical Process Control Techniques with Examples, Process Capability, and Sigma Level with Examples

Hypothesis Testing and ANOVA Analysis, Measurement System Analysis (MSA)

Multiple Regression for Process Modelling.

Introduction to Design and Analysis of Experiments for Quality Improvement

Factorial Design (2k) with Examples

Response Surface Methodology (RSM) and CCD Design with Examples, Multiple Response Optimization

Fractional Factorial Design with Examples, Taguchis Experimental Design.

**Management and Entrepreneurship**

Introduction- Meaning- nature and characteristics of Management, Scope and Functional areas of management -Management as a science, art of profession -Management &Administration – Roles of Management, Levels of Management, Development of Management Thought early management Basic functions of management – planning, organizing, staffing, directing and controlling. Productivity: definition, measurement. Work study and its role in improving productivity of an organization. Concepts of human resource management – selection, training and development. Finance management – capital budgeting techniques, payback period, ARR, NPV, IRR, PI; Sources of capital; Costs concepts and Break even analysis.

Entrepreneurship: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship. Modern Small Business Enterprises: Role of Small Scale Industries, Impact of Globalization and WTO on SSIs, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Ancillary Industry and Tiny Industry, Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance

Text books

1.Essentials of Management, Koontz an and O’Donne

2. Finance Sense, Prasanna Chandra

3. Industrial Management, M E ThukaramRao.

4. Work Study, I.L.O.

5. A Management Guide to PERT/CPM, J D Wiest and F K Levy.

**Management information system :**

**Elective V**

**Pipeline engineering:**

Introduction: pipelines, risers, valves, pigging, flow metering equipment; pipeline vs. other forms of transportation.

Flow dynamics; multiphase flow and slugging; hydrate, wax, and scale deposition.

Stress analysis; vibration, buckling and collapse.

Steel materials: types, overview of manufacturing processes.

Offshore pipeline construction, lay barge configurations, pipe coating, pipe laying procedures, underwater welding.

On shore pipe line construction. Installation: route location survey, GIS image processing, S-lay, J- lay, and tow-in, control of sag and over bend.

Design of cathodic protection system; thermal coatings, field joint coatings.

Assessment of cracks, dents, and corrosion defects in pipeline under static and dynamic loading conditions.

Crude conditioning with additives.

Safety and security of oil pipelines

Pipeline network analysis, software's.

Text Books:

Mohitpour M., Golshan H., Murray A., Pipeline Design & Construction: A Practical Approach, ASME 2007.

Guo B, Song S, Ghalambor A., Lin T., Chacko J, Offshore pipelines, Gulf Professional Publishing 2005.

**Introduction to Lubricants:**

The fundamentals of lubricants business

Lubricant value chain

Types of Lubricants- Automotive, Industrial, Marine, Railroad, Air

Applications of lubricants – Automotive (Trucks, Cars, 2-Wheelers, Tractors, Gear Oils, Natural Gas Engine Oils etc.) and Industrial (Cutting Oils, Rust Preventives, Rolling Oils, Compressor Oils, Hydraulic, Drilling Oils etc.)

Properties of Lubricants

Bio-Lubricants

Fundamentals of Base Oils

Type of Crude Oils

Refinery process – Brief introduction

Base Oil Groups

Properties of Base Oils

Fundamentals of Additives

Properties & key characteristics

Composition of additives for various applications

Additive Chemistry

Types of additives

Performance contribution of additive to Lubricants

Lubricants – Automotive

Understanding of Key specifications like API, JASO, ACEA

Global Specifications and Viscometrics

India- Current scenarios of Lubricants in India & Future trends

Lubricants-Industrial, Marine, Railroad, Air sector Indian Lubricant Market-

Current size & key players

Growth Potential

New trends impacting lubricants, base Oils and additive industry

BS IV to BS VI Transition by 2020

Transition towards high-quality lighter lubricants

New slate of Base Oils over next 10 years

Finance and Cost optimization of Lubricants

Tools and techniques: value engineering and collaborative optimization

Global best practices to drive down the total costs of ownership

## Waste Water Management

Introduction to water and wastewater engineering, Methods for characterizations of wastewater properties, physical, chemical and biological process for wastewater treatment, primary, secondary and tertiary treatment including suspended growth and attached growth methods. Advanced oxidations process for removal of recalcitrant components in wastewater, nutrient removal, sludge treatment and its removal, progress in zero- discharge techniques. Case studies related to treatment of Industrial and municipal effluents, standards and regulations.

Text Books:


1. W. Eckenfelder (Jr.) Industrial Water Pollution Control, McGraw Hill 1999.
2. G. Tchobanoglous, .L. Burton, and H.D. Stensel, Wastewater Engineering Treatment and Reuse (Metcalf& Eddy),McGraw Hill 2002.
3. A. P. Sincero and G.A. Sincero


## Nano Materials for Hydrocarbon Industry

Introduction to metallic nanoparticles, metal oxide nanoparticles, carbon nanotubes, magnetic nanoparticles, nanoporous materials.

- Synthesis: Chemical, electrochemical, thin films – CVD, PVD, Langmuir-Blodgett, mechanical (attrition), sol-gel, nanolithography.
- Functionalization: Ligand incorporation, biomolecule conjugation, polymer coating.
- Physical and chemical properties at nanoscale; Nanomaterial characterization: SEM, TEM, AFM, scanning probe microscopy, scanning tunneling microscopy, diffraction and scattering techniques, vibrational spectroscopy.
- Use of nanomaterials in exploration and reservoir characterization, drilling, cementing, production, stimulation, petroleum refining, fuel production, and chemical sensing.
- Use of nanomaterials in lubricants

# Proposal to Start B.Tech Program in Mechanical Engineering at IIPE, Visakhapatnam

## Appropriateness to Mission

The energy sector in India require skilled Mechanical Engineering with significant expertise in conventional and renewable energy production technologies. The renewable energy industry has seen impressive, global growth over the last decade, and mechanical engineers have played a major role in enabling the world's transition to clean energy and more sustainable practices. Mechanical engineers significantly contribute to the design of solar, geothermal power, wind, hydro, steam and gas turbines. Many of the key skills that mechanical engineers learn and develop in mechanical engineering graduate programs have a wide range of applications in energy sector. Apart from this Mechanical Engineers have a huge role to play in the oil and gas industries equipment and machinery design. IIPE with its unique vision and mission can now implement 'B-Tech in Mechanical Engineering' program as defined in its Detailed Project Report (DPR) in order to develop qualified human capitals to meet the man power requirement in various energy sector.

## Program goals

The goal of the 4-year B-Tech Program in Mechanical Engineering is to produce highly skilled Mechanical engineers with specialized knowledge on petroleum and energy sectors.

## Student Admission Requirement

Students should have qualified Advance JEE (IIT) which is an all-India examination conducted across the country jointly by various IITs.

Eligibility Criteria: Valid advance JEE score

Starting Capacity of Students: 30

Proposed Year of Stating: 2022-2023.

# COURSE STRUCTURE and SYLLABUS

For

# B. Tech. in Mechanical Engineering

For Academic Session 2022-23


## Indian Institute of Petroleum and Energy

2nd Floor, Main Block, AUCE (A), Andhra University

Visakhapatnam, Andhra Pradesh - 530003

भारतीय पेट्रोलियम और ऊर्जा संस्थान
Indian Institute of Petroleum and Energy (IIPE)
2nd Floor, Main Block, AUCE (A), Andhra University
Visakhapatnam, Andhra Pradesh – 530003

# COURSE STRUCTURE

| Semester-I | | | | |
|---|---|---|---|---|
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 10001 | Engineering Mathematics – I (Calculus) | 3 - 1 - 0 | 4 |
| 2 | BS 10002 | General Chemistry | 3 - 1 - 0 | 4 |
| 3 | ME 10001 | Engineering Mechanics | 3 - 1 - 0 | 4 |
| 4 | BS 10005 | Earth Energy and Environment | 2 - 0 - 0 | 2 |
| 5 | BS 10009 | Fundamentals of Electrical Systems | 3 - 1 - 0 | 4 |
| 6 | BS 10006 | English for Communication | 1 - 0 - 2 | 2 |
| 7 | ME 10002 | Engineering Drawing & Computer Graphics | 1 - 0 - 3 | 3 |
| 8 | BS 19002 | Physical Chemistry Lab | 0 - 0 - 3 | 2 |
| 9 | EA 10001 | EAA – 1 | 0 - 0 - 2 | 0 |
| | | **Total** | **16-4-8** | **25** |
| **Semester-II** | | | | |
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 10007 | Engineering Mathematics – II (Linear Algebra, Differential Equations & Complex variables) | 3 - 1 - 0 | 4 |
| 2 | ME 10003 | Strength of Materials | 3 - 1 - 0 | 4 |
| 3 | BS | Introduction to Materials Science | 3 - 0 - 0 | 3 |
| 4 | BS 10004 | Programming and Data Structure | 3 - 1 - 3 | 6 |
| 5 | ME 10004 | Workshop-I | 2 - 0 - 0 | 2 |
| 6 | BS 10010 | Fundamentals of Biological Systems | 2 - 0 - 0 | 2 |
| 7 | BS 19012 | Organic Chemistry Lab | 0 - 0 - 3 | 2 |
| 8 | BS 19009 | Electrical Systems Lab | 0 - 0 - 3 | 2 |
| 9 | EA 10002 | EAA – 2 | 0 - 0 - 2 | 0 |
| | | **Total** | **16 - 3 - 9** | **25** |

**Note: 1st Year syllabus is common for Petroleum, Chemical and Mechanical Engineering.**

| Semester-III | | | | |
|---|---|---|---|---|
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 20001 | Transform Calculus & Probability | 3-1-0 | 3 |
| 2 | BS 20007 | Numerical Methods | 2-0-2 | 3 |
| 3 | BS 20002 | Fluid Mechanics & Multiphase Flow | 3-1-0 | 4 |
| 4 | ME 20005 | Introduction to manufacturing Processes | 4-0-0 | 4 |
| 5 | BS 20003 | Information Technology | 2-0-3 | 4 |
| 6 | ME 20012 | Machine Drawing Lab | 0-0-2 | 2 |
| 7 | ME 20006 | Introduction to Mechanical Engineering | 0-0-3 | 2 |
| 8 | EA 20003 | EAA III | 0-0-2 | 0 |
| | | **Total** | **14-2-12** | **22** |
| **Semester-IV** | | | | |
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 20006 | Statistical Techniques | 3-0-0 | 3 |
| 2 | ME 20007 | Engineering Thermodynamics | 3-1-0 | 4 |
| 3 | ME 20008 | Heat Transfer | 3-1-0 | 4 |
| 4 | ME 20009 | Kinematics and Dynamics of Machines | 3-1-0 | 4 |
| 5 | ME 20010 | Fluid Machines | 2-1-0 | 3 |
| 6 | ME 20011 | Fluid Flow Lab and Design | 0-0-3 | 2 |
| 7 | ME 20013 | Material Testing Lab | 0-0-2 | 2 |
| 8 | EA20004 | EAA IV | 0-0-2 | 0 |
| | | **Total** | **14-4-5** | **22** |

| Semester-V | | | | |
|---|---|---|---|---|
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | BS 30001 | Industrial Psychology & Professional Ethics | 2-0-0 | 2 |
| 2 | ME 30014 | Design of Machine elements | 3-1-0 | 4 |
| 3 | ME 30015 | Advance Mechanics of Solids | 3-1-0 | 4 |
| 4 | ME 30016 | I.C Engines and Gas Turbines | 3-1-0 | 4 |
| 5 | ME 30017 | Machining and Machine tool operation | 2-0-0 | 2 |
| 6 | ME 30018 | Systems and Control | 3-0-0 | 3 |
| 7 | ME 30019 | Heat Transfer Lab | 0-0-3 | 2 |
| 8 | ME 30020 | Workshop II | 0-0-2 | 2 |
| | | **Total** | **16-3-5** | **23** |
| **Semester-VI** | | | | |
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | ME 30021 | Applied Thermofluids | 3-1-0 | 4 |
| 2 | ME 30022 | Industrial Engineer and Management | 3-0-0 | 3 |
| 3 | ME 30023 | Elective- I | 3-0-0 | 3 |
| 4 | BS 30003 | Economics | 2-0-0 | 2 |
| 5 | BS 30004 | Machine Design Practice | 0-0-3 | 2 |
| 6 | ME 30024 | Fluid Machines Lab | 0-0-3 | 2 |
| 7 | ME 30025 | I.C Engines and Fuel Lab | 0-0-3 | 2 |
| 8 | BS 20005 | Innovations Lab | 0-0-3 | 2 |
| | | **Total** | **11-1-12** | **20** |

| Semester-VII | | | | |
|---|---|---|---|---|
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | ME 40024 | Elective II | 3-0-0 | 3 |
| | BS | Optimization Techniques | 3-0-0 | 3 |
| 2 | BS 40002 | Data Analytics and AI | 3-0-0 | 3 |
| 3 | CH 40001 | Project Engineering and Management | 3-0-0 | 3 |
| 4 | BS 40001 | Industrial Safety | 1-0-0 | 1 |
| 5 | BS 48001 | Industrial Training | 0-0-0 | 2 |
| 6 | ME 40024 | Thermofluids lab | 0-0-3 | 2 |
| 7 | BS 47001 | Project I | 0-0-6 | 4 |
| | | **Total** | **10-0-9** | **21** |
| **Semester-VIII** | | | | |
| **S. No.** | **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
| 1 | EE | Elective III | 3-0-0 | 3 |
| 2 | MGMT | Elective IV | 3-0-0 | 3 |
| 3 | PE | Elective V | 2-0-0 | 2 |
| 4 | ME 40024 | Computer Aided Design and Manufacturing | 2-0-0 | 3 |
| 5 | BS 47002 | Project II | 0-0-9 | 5 |
| 6 | BS 48002 | Comprehensive Viva-Voce | 0-0-0 | 2 |
| | | **Total** | **10-0-9** | **18** |

## ELECTIVES

| | | | | |
|---|---|---|---|---|
| **Elective I & II** | ➢ Mechanical Vibrations<br>➢ Power Plant Engineering<br>➢ Automobile Engineering<br>➢ Tribology<br>➢ Rapid Proto-typing<br>➢ Composite materials<br>➢ Mechatronics<br>➢ Robotics<br>➢ Finite element analysis<br>➢ Computational Fluid Dynamics<br>➢ Micro and Nano Engineering<br>➢ Machine Learning and AI<br>➢ Applied Data Science<br>➢ System Modelling and simulation | | | |
| **Elective III** | Bio Energy | Solar Energy, Photovoltaic Energy | Nuclear wind and geothermal energy | Energy conversions device |
| **Elective IV:** | Supply Chain Management | Management Techniques for Industrial Sector | Entrepreneurship | Management information system |
| **Elective V:** | Pipeline Engineering | Waste Water Management | Introduction to Lubricants | Nano Materials for Hydrocarbon Industry |

***Note**: **Electives will be offered based on the availability of resource person**

# COURSE SYLLABUS

## Semester-I

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10001 | **Engineering Mathematics – I (Calculus)** | 3 - 1 - 0 | 4 |

**Functions of single variable:** Sequences in real numbers, limits and continuity of real valued functions on intervals, extreme values of functions in interval, Intermediate value property and differentiation, Mean Value Theorems, Indeterminate forms, Taylor's formula, convergence of series, root test, ratio test, Cauchy condensation test, alternating series, Leibnitz's test, absolute and conditional convergence, power series, radius of convergence, Taylor series, Riemann integration, Riemann integrable functions, Mean value theorems of Integrals, Improper integrals, Beta and Gamma functions and their convergence, comparison test, absolute convergence.

**Functions of several variables:** Continuity, partial derivatives, directional derivatives and gradient, differentiability, chain rule, tangent plane and normal line, Euler's theorem on homogeneous functions, Taylor's theorem, extreme values, Lagrange multipliers, double and triple integrals, volume and area, change of variables, surface area, surface integrals, line integrals, Green's theorem, vector fields, divergence and curl of a vector field, Stoke's theorem, Divergence theorem.

**Reference**:

1. G. B. Thomas Jr, M. D. Weir and J. R. Hass, Calculus, Pearson Education (2009).
2. Hughes-Hallett et al., Calculus - Single and Multivariable (3rd Edition), John-Wiley and Sons (2003).
3. James Stewart, Calculus, Thomson (2003).
4. N. Piskunov, Differential and Integral Calculus Vol.1-2, Mir publishers, (1974).
5. Tom M. Apostol, Calculus Vol. 1-2, Wiley, (2007).
6. S.R. Ghorpade, B.V.Limaye, A course in Calculus and Real Analysis, Springer(2017)
7. S.R. Ghorpade, B.V.Limaye, A course in Multivariable calculus and Analysis, Springer(2017)

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10002 | **General Chemistry** | 3 - 1 - 0 | 4 |

**Thermodynamics of Chemical Processes**: Concept of entropy, Chemical potential, Equilibrium conditions for closed systems, Phase and reaction equilibria, Maxwell relations, Real gas and real solution. Electrochemical Systems: Electrochemical cells and EMF, Applications of EMF measurements: Thermodynamic data, activity coefficients, solubility product and pH, corrosion.

**Kinetics of Chemical Reactions**: Reversible, consecutive and parallel reactions, Steady state approximation, Chain reactions, Photochemical kinetics.

**Basic hydrocarbon chemistry**: Alkane, Alkene, Alkyne: structure, stereochemistry, physical and chemical properties, chemical reactivity, separation.

**Fundamentals of Microwave, IR and UV-VIS Spectroscopy**: Basic concepts of spectroscopy, Selection rule, Determination of molecular structure.

**Reference:**

1. Physical Chemistry by G.W. Castellan (Addison Wesley Publishing Company)

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10003 | **Engineering Mechanics** | 3 - 1 - 0 | 4 |

**Moment of a force about a point and about an axis:** Couple moment; Reduction of a force system with a force and a couple.

**Equilibrium:** Free body diagram; Equations of equilibrium; Problems in two and three dimensions; Plane frames and trusses.

**Friction:** Laws of Coulomb friction, problems involving large and small contact surfaces; Square threaded screws; Belt friction; Rolling resistance.

**Kinematics and Kinetics of particles:** Particle dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables; Central force motion.

**Properties of areas:** Moments of inertia and product of inertia of areas; Polar moment of inertia; Principal axes; Principal moments of inertia.

**Reference:**

1. Engineering Mechanics Statics and Dynamics by Irving H Shames.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10005 | **Earth Energy and Environment** | 2 - 0 - 0 | 2 |

- Understanding the interconnection in earth energy and environment systems uses the principles of Geology, Biology, Engineering and Socioeconomic dynamics- Understanding of the global changes in different time scales specially emphasizing on technology and socio-political approaches applied to earth, oceans, water, energy, food and population will also be addressed.
- Information on statutory Bodies & Regulations. basics of International protocols (viz Paris Agreement etc.), MINAS standard, changes in fuel quality specification with respect to Sulphur, Benzene etc.
- The following are the components: Anthropogenic and natural changes in the atmosphere, ocean and terrestrial and freshwater ecosystem.
- Greenhouse gases and climate change, deforestation, species extinction, human population growth and resource usage.
- Understanding the human-environment, interaction with a focus on culture, history, economics, policy and the role of the state.
- **Case studies:** Environmental degradation, loss of biodiversity, and resource sustainability, complex environmental problems caused by human activities in interaction with natural changes in the earth system.

**Reference:**

1. Environmental Studies: From Crisis to Cure, R. Rajagopalan, OUP India, 3rd Edition.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10009 | **Fundamentals of Electrical Systems** | 3 - 1 - 0 | 4 |

- Conventional sources of electrical power generation- Thermal, Hydro and Nuclear Power generation. Typical schematic diagram of generation, transmission and distribution. Concept of voltage and current sources, solution of DC resistive circuits based on Mesh current and Node voltage methods.
- Solution of DC resistive circuits using Thevenin's and Norton's Theorems. Solution of circuit problems (containing resistive elements) using different techniques having voltage and current sources.

- Basic concept of single phase (1-phase) ac voltage generation. Evaluation of average and effective (rms) values, form-factor and peak factors of sinusoidal quantities, periodic wave forms, significance of rms value of a wave form. Concept of phasor, joperator, representation of sinusoidal quantities by a phasor diagram, Phasor addition and subtraction, Complex representation of impedance (R-L, R-C, R-L-C), concepts real, reactive and apparent power in an ac circuit steady state solutions of ac R-L-C circuits. Steady state solution of 1-phase circuit problems.
- Three-phase power generation, concept of balanced load, relationships between (i) line vine voltage and phase voltage (ii) line current and phase current in a balanced load, phasor diagram, calculations of real, reactive and apparent powers, steady state solution of 3-phase circuit problems.
- Working principle of Wattmeter. Three phase power measurement of a balanced or unbalanced load using two-wattmeter method. Transformer construction, working principle of transformer, an emf equation of a transformer. Losses in a transformer, significance of transformer ratings. Open and short circuit tests of a transformer and computation of transformer parameters, approximate equivalent circuit of transformer, significance voltage regulation. Mathematical expression of voltage regulation, maximum efficiency of a transformer, solution of numerical problems on transformer.
- Working principle of Induction Motor (IM), classification of IM, concept of rotating magnetic field in an IM, slip, rotor frequency, understanding the loading of an IM, losses in an IM, significance of IM rating.
- Per-phase approximate equivalent circuit of a balanced 3-phase IM, Power flow diagram of an induction motor from input power to the shaft power. Expressions for (i) input power (ii) air-gap power and torque developed (iii) mechanical power and torque developed (iv) shaft power and shaft torque.
- Torque-speed characteristics of an IM, efficiency of IM, solution of numerical problems on IM.

**Basic Electronics**

- Semiconductor Physics; Semiconductor Devices (Diode, Zener Diode, Transistors etc.); ransistor characteristics and biasing. Half-wave & Full-wave rectifiers.
- Operational Amplifiers; realization of filters (low-pass, high-pass, band-pass and band stop filters). Different classes of power amplifiers (Class-A, Class-B, Class-AB).

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10006 | **English for Communication** | 1 - 0 - 2 | 2 |

This foundational course aims to help students coming from different language backgrounds acquire fluency in both spoken and written English in the workplace. Various ways of analysis of Root Cause analysis and project report writing. The course includes three components **Language, Speaking and Writing**. Lectures and Sessional will be conducted to improve the skills required these three areas. Lectures will be aimed to introduce the learners to the basic concepts in communication, while sessional will give practical experience. The purpose of this course is to help students to communicate English more efficiently.

**Section A (Lecture topics):** Introduction to communication; Language and grammar skills; Speaking and writing skills

**Section B (Sessional):** Building Vocabulary; Building sentences; Grammar, Pronunciation drills; Phonetics, vowels; Diphthongs, consonants; Stress; Rhythm and intonation; Conversational skills; Meta Language, the writing process; Writing with a thesis; Writing topic sentences; Writing a paragraph and linking paragraph.

**Reference:**

1. Technical Communication: English Skills for Engineers by Meenakshi Raman and Sangeeta Sharma (OUP India)

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10011 | **Engineering Drawing & Computer Graphics** | 1 - 0 - 3 | 3 |

- Introduction to IS code of drawing
- Conics and Engineering Curves – ellipse, parabola, hyperbola, cycloid, trochoid, involute
- Projection of lines – traces, true length
- Projection of planes and solids
- Isometric projection
- Introduction to CAD tools - Basics of Auto-CAD/Solid Works; Creation of Points, Curves, Surfaces, Solids, Dimensioning using CAD tool
- Introduction of Development and Intersection of surfaces (Development of surfaces Development of prisms, pyramids and cylindrical & conical surfaces using CAD tools)
- Usage and interpretation of drawings of different Equipment and 3D plot plan models

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 19002 | **Physical Chemistry Lab** | 0 - 0 - 3 | 2 |

- Measurement of surface tension, CMC of a surfactant
- Measurement of the coefficient of viscosity for water and polymer
- Conductometric titration
- pH-metric/potentiometric titration
- Solubility product
- Kinetics of ester hydrolysis
- Estimation of Fe2EDTA titration
- Codes / standards /Laboratory Accreditations /ASTM Methods requirement and applications

## Semester-II

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10007 | **Engineering Mathematics – II (Linear Algebra, Differential Equations and Complex variables)** | 3 - 1 - 0 | 4 |

**Linear Algebra:**

Algebra of matrices, Vector spaces, subspaces, linear dependence of vectors, basis and dimensions, linear transforms, matrix representation of a linear transform, rank-nullity theorem, rank and inverse of a matrix, solution of an algebraic equations-consistency conditions, Gaussian elimination and Gauss-Jordon methods, Hermitian, skew Hermitian and unitary matrices, eigenvalues and eigenvectors, Cayley-Hamilton theorem, diagonalizability, bilinear forms.

**Differential equations:**

First order differential equations: Exact Equations, integrating factors, Reducible to exact differential equations, linear and Bernoulli's form, Orthogonal trajectories, Lipschitz condition, Picard's theorem, Examples of non-uniqueness.

Homogeneous and non-homogeneous second order ODE's with constant coefficients, Characteristic equation, Linear dependence and Independence, Existence of solutions, Wronskian, method of variation of parameters, general linear differential equations with constant coefficients, Method of undetermined coefficients, Cauchy-Euler equations, System of differential equations.

**Complex Variables:**

Limit, continuity, differentiability and analyticity of functions, Cauchy-Riemann equations, line integrals in complex plane, Cauchy's integral theorem, independence of path, existence of indefinite integral, Cauchy s integral formula, derivatives of analytic functions, Taylor s series, Laurent s series, Zeros and singularities, Residue theorem, evaluation of real integrals.

**References:**

1. G. Strang, Linear Algebra and its applications
2. K. Hoffman and R. Kunze, Linear Algebra, Pearson publisher.
3. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).
4. S.L. Ross, Differential Equations, Third Edition, Wiley-India (2004).
5. R. V. Churchill, J. W. Brown, Complex Variables and Applications, Mc-GrawHill, (1990).
6. S. Ponnusamy, H. Silverman, Complex Variables with Applications, Birkhauser, (2006).

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | **Strength of Materials** | 3 - 1 - 0 | 4 |

**Concept of stress and strain:** Normal stress, shear stress, state of stress at a point, ultimate strength, allowable stress, factor of safety; Normal strain, shear strain, Hooke's law, Poisson's ratio, generalized Hooke's law; Analysis of axially loaded members

**Material of construction**: Reactors, Tubes etc.,

**Torsion:** Torsion of cylindrical bars, torsional stress, modulus of rigidity and deformation.

**Flexural loading:** Shear and moment in beams; Load, shear and moment relationship; Shear and moment diagrams; Flexure formula; Shear stress in beams; Differential equation of the elastic curve, deflection of beams

**Transformation of stress and strain:** Transformation of stress and strain; principal stresses; principal

strains; Mohr's circle for stress and strain.
**Combined loading:** Axial and torsional; axial and bending, Axial, torsional and bending
**Column:** Buckling of slender columns, Euler bucking load for different end conditions.

**Reference:**

**1.** Elements of Strength of Material by Timoshenko and Young (East West Press)

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS | Introduction to material science | 3 - 0 - 0 | 3 |

Introduction, Classifications of materials, Atomic Structure & Interatomic Bonding, The Structure of Crystalline Solids
Imperfections (Defects) in Solids
Diffusion, Mechanical Properties of Metals
Dislocations & Strengthening Mechanisms
Failure
Phase Diagrams
Development of Microstructure and Control of
Mechanical Properties in Metals
Applications and Processing of Metal Alloys Structures and Properties of
Ceramics Applications and Processing of Ceramics
Polymer Structures
Characteristics, Applic. & Processing of Polymers
Composites
Corrosion and Degradation of Materials Electrical Properties, Thermal Properties, Magnetic Properties
Optical Properties, Biomimetic Materials

**Reference:**

1.W. D. Callister, Jr: Materials Science and Engineering- An Introduction, John Wiley and Sons, N.Y,
2. J. F. Shackelford: Introduction to Materials Science for Engineers, Mc-Millan Publishing Co., N.Y. 1992

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10004 | **Programming and Data Structure** | 3 - 1 - 3 | 5 |

Introduction to digital computers; Introduction to programming variables, assignments; expressions; input/output; Conditionals and branching; Iteration; Functions; Recursion; Arrays;
Introduction to pointers; Character strings; Time and space requirements; Searching and sorting;Structures;
Introduction to data-procedure encapsulation; Dynamic allocation; Linked structures.
Introduction to data structures a stacks and queues. (A programming language like C/C++ may be usedas a basis language. The same language must be used in the laboratory).

**Programming & Data Structure LAB:**

- Familiarization of a computer and the environment and execution of sample programs
- Expression evaluation
- Conditionals and branching
- Iteration
- Functions
- Recursion
- Arrays
- Structures
- Linked lists, Data structures

**Reference**

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (MIT Press)

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| | **Workshop** | 0-0-3 | 2 |

- Workshop Safety Precautions
- Machining process (Lathe Machines operations: (Turning, Knurling, facing drilling, taper turning)
- Joining Processes: Welding, brazing
- Grinding, Semi-finishing and finishing processes
- TIN Smithy and Sheet Metal Operations
- Carpentry
- Foundry

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 10010 | **Fundamentals of Biological Systems** | 2-0-0 | 2 |

**Unit 1:** Cellular Biology (10 Lectures) Ultra structure of bacteria, plants and animal cells; cell division, cell cycle and apoptosis; ATP synthesis and Glycolysis; Respiration and photosynthesis.

**Unit 2:** Chemical Biology (10 Lectures) Proteins: structure and sequencing; Enzymes: mechanism, kinetics and inhibition; DNA: structure and sequence, replication, recombination; RNA synthesis; Genetic code and protein biosynthesis; Recombinant DNA technology.

**Unit 3:** Bio-Thermo-Fluidics and Transport Processes (8 Lectures) Noncovalent interactions and free energy changes in biological processes; Fundamentals of momentum, heat and mass transport as applied to biological systems; Human body as a thermodynamic system; Blood Rheology, Fluid mechanical aspects of some diseases and organs; Bio-Micro devices.

**Unit 4:** Impact of Biology on Society and Mankind (2 Lectures) Crop management, Disease control, Biological Hazards and safety; Unsolved Problems in Biology.

**References:**

1. Lehninger Principles of Biochemistry, Nelson and Cox, Biochemistry by Berg, Tymoczko and Stryer, Biochemistry by Voet and Voet, Molecualr Cell Biology by Lodish et al, Molecular Biology of Genes by Watson et al., Gene IX by Benjamin

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 19012 | **Organic Chemistry Lab** | 0-0-3 | 2 |

- Identification of organic compounds from a binary mixture by qualitative analysis
- Estimation of glucose/cane sugar. Estimation of base content and acid content of commercially available antacid and vitamin C respectively
- Determination of solubility of solid sample in different solvent
- Recrystallization of solid compound from a solution
- Esterification reaction
- Extraction
- Chromatographic separation
- Quantitative analysis of organic compound
- Determination of melting point

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 19009 | **Electrical Systems Lab** | 0-0-3 | 2 |

- To measure the armature and field resistance of a DC machine. in R-L-C series circuit exited by single phase) AC supply.
- Verification of circuit theorems – Thevenin's and superposition theorems (with DC sources only).
- Measurement of current, voltage and power
- Open circuit and short circuit tests on a single phase transformer
- Connection and starting of a three phase induction motor using direct on line (DOL) or star – delta starter
- Connection and measurement of power consumption of a fluorescent lamp and voltage – current characteristics of incandescent lamps.
- Determination of open circuit characteristics (OCC) or a DC generator.
- Two wattmeter method of measuring power in three phase circuit (resistive load only).
- Familiarization with electronic components and usage of multimeter
- Familiarization with oscilloscope, signal generator and further usage of multimeters
- Frequency-response and square-wave testing of R-C, C-R and R-L networks
- Voltage Rectifiers2. To calibrate a test (moving iron) ammeter and a (dynamometer) Wattmeter with respect to standard (DC PMMC) ammeter and voltmeters
- Studies on Common-Emitter amplifiers
- Studies on analog circuits using OP-AMP
- Studies on logic gates

## Semester-III

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 20001 | **Transform Calculus & Probability** | 3-1-0 | 3 |

- Laplace Transform: Definition of Laplace transform, linearity property, conditions for existence of Laplace transform, first and second shifting properties, Laplace transform of derivatives and integrals, unit step function, Dirac-delta function and error function, differentiation and integration of transforms, convolution theorem, inversion, periodic functions, evaluation of integrals by Laplace transforms, solution of initial and boundary value problems.
- Fourier Series: Orthogonal and Orthonormal functions, periodic functions, representation of a function in terms of orthonormal functions, Fourier series representation of a function and its convergent properties, half range series, sine and cosine series, complex form of a Fourier series, Fourier integral representation of a function, Parseval's identity.
- Fourier Transform: Fourier transform, Fourier sine and cosine transforms, linearity, scaling, frequency shiftingand time shifting properties, self-reciprocity of Fourier transform, convolution theorem, Applications to boundary value problems.
- Probability: Sample space, events, classical, relative frequency and axiomatic definitions of probability, addition rule, conditional probability, multiplication rule, independence, total probability, Bayes' theorem.
- Random variables: Discrete, continuous and mixed random variables, cumulative distribution, probability mass and probability density functions, Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Normal and Gamma distributions.
- Functions of random variables, expectation, variance, moments, jointly distributed random variables and joint cumulative probability distribution functions, jointly continuous random variables, independent random variables, covariance, sum of random variables.

**Text and Reference Books:**

1. R. K.Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa publisher
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley publisher.
3. Sheldon Ross, A first course in probability, Pearson publisher.
4. W. Feller, An introduction to Probability theory and its applications
5. Peter V, O'Neil, Advanced Engineering Mathematics, 6th edition.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 20007 | **Numerical Methods** | 2-0-3 | 3 |

- Numerical errors, Error propagation, Taylor's series. convergence, order, and stability.
- Finding roots of equations: Bisection, Regula-falsi, Newton-Raphson, secant methods and their convergence. Basic concepts of iteration and solutions.
- Interpolation by polynomials: Lagrange and Newton divided differences methods, error of the interpolating polynomial, piecewise linear and cubic spline interpolation.
- Numerical differentiation and integration of functions, Rectangle, Trapezoidal and Simpson's rules, Composite rules, error formulae, Gaussian quadrature rules.
- Matrices, vectors, Norms, ill-conditioning, System of Linear Equations, Gaussian elimination, Gauss-Jordan method, LU and Cholesky decomposition, Iterative methods: Gauss-Seidel and Gauss-Jacobi, Eigen value problems: power method, QR method, Gershgorin's theorem.
- Linear and nonlinear Least Squares, Newton-Raphson Method in two variables.
- Numerical Solution of ODE: Taylor's, Euler's, Modified-Euler, Runge-Kutta methods.

- Numerical Solutions of PDE: Heat, Wave and Laplace equations
- Exposure of packages like MATLAB/C/C++/Fortran

**Text and Reference Books:**

1. S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach (3rd Edition),McGraw-Hill, 1980.
2. K. Atkinson, An Introduction to Numerical Analysis (2nd Edition), John-Wiley & Sons, 1989.
3. S.S. Sastry, Introductory Methods of Numerical Analysis - Prentice Hall of India
4. E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999).

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 20002 | **Fluid Mechanics & Multiphase Flow** | 3-1-0 | 4 |

- Definition of Fluid, Lagrangian and Eulerian methods of description; Velocity Field: Streamline and stream function, Vorticity, Stress Field; Rheology: Newtonian/non-Newtonian Fluids
- Classification of Fluid Flow: Viscous/Inviscid, Laminar/Turbulent, Compressible/ Incompressible, Internal/External, Rotational/Irrotational
- Fluid Statics: Pressure variation in static fluids, manometer, capillary hydrostatics; Macroscopic mass andmomentum balance using integral control volume method, Euler & Bernoulli equations, Internal Incompressible Viscous Flow. Fully developed laminar flow in pipes, Couette and annular flows; HagenPoiseulle Equation
- Turbulent flow: Eddy viscosity, Universal velocity profile; Skin and Form Friction, friction factor and friction factor versus Reynolds number relation, Calculation of Head Losses in pipes and fittings, Converging and diverging nozzles, Solution of single and multi-path pipe flow systems.
- External Incompressible Viscous Flow: Flow around immersed bodies, Drag and Lift, Drag coefficient
- Flow Devices and Instruments: Valves, reciprocating and centrifugal pumps, compressors, Flow meters (Head/Area): Venturi, Orifice,Rotameter
- Introduction to Hydrodynamics of Gas-liquid flow: Homogeneous flow model, Separated flow model, Bubble formation and dynamics, Mass bubbling and liquid entrainment

**Text and Reference Books:**

1. Introduction to Fluid Mechanics by R. W. Fox & Alan T. McDonald
2. Fundamentals of Multiphase Flow by C. E. Brennen, Cambridge University Press
3. Fluid Dynamics and Heat Transfer by James G. Knudsen and Donald L. Katz, McGraw-Hill, New York.
4. Coulson & Richardson's Chemical Engineering: Fluid Flow, Heat Transfer & Mass Transfer, Vol.1.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | **Introduction to Manufacturing Process** | 4-0-0 | 4 |

Fundamentals of Metal Casting, Process and Equipment, Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding. Additive Manufacturing

**Reference:**

De'Garmo, E. Paul, Process and Materials Manufacturing A. Ghosh and A. K. Mallik, Manufacturing Science, East West Press, New Delhi
P. N. Rao, Manufacturing Technology - Foundry, Forming and Welding | Volume1, McGraw Hill - 279 -Page 6 of 7P. N. Rao
Manufacturing Technology: Metal Cutting and Machine Tools | Volume 2, McGraw Hill Kalpakkjain,
Manufacturing Engineering and Technology, Pearson Education O. P. Khanna, Welding Technology P. I. Jain, Principles of Foundry Technology

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 20004 | **Object Oriented Programming** | 2-0-3 | 4 |

- Fundamental concepts of object oriented programming: Introduction to the principles of object-oriented programming (classes, objects, messages, encapsulation, inheritance, polymorphism, exception handling,and object-oriented containers)
- Object design implementation in a programming language, e.g., C++ or java or Python
- Object oriented database systems: Object oriented data model, query languages, storage organization andindexing techniques; object relational databases

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | Machine Drawing Lab | 0-0-3 | 2 |

Introduction to computer aided drafting, IS/ISO codes; Limits, tolerances and Fits, Surface finish; Important symbols in machine drawing. Assembly and part drawings of simple assemblies and sub-assemblies of machine parts viz., couplings, clutches, bearings, gear assemblies, I.C. Engine components, valves, machine tools, various types of Joints etc. using 3D Modelling software's.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | **Introduction to Mechanical Engineering** | 2-0-0 | 2 |

Introduction to Mechanical Engineering, Impact of Mechanical engineering
Thermal Engineering, Design, manufacturing Engineering. Role and Responsibilities of a Mechanical Engineers, IC Engines – 2 Stroke and 4 stroke systems in IC Engines. Automobiles - Transmission systems, Suspension system, ABS, Airbag Systems, E-Vehicles.
Introduction to Energy Systems - Power plants, Types, Gas Turbines, Steam Turbines, Utility boilers, R & A/C system
Green Energy production and Devices – Fluid Movers, Pumps and Compressors, Engineering materials, Machine elements and its functions Manufacturing, Classification, Metal forming, Casting, Lathe, drilling machines, Milling machines, Metal joining, Additive Manufacturing.

**Reference:**

**Wickert, J. and Lewis, K., *An introduction to mechanical engineering*. Cengage Learning.**

## Semester-IV

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| BS 20006 | **Statistical Techniques** | 3-0-0 | 3 |

- **Sampling distributions**: Chi-square, t and F distributions, random sample, sample mean and sample variance, the central limit theorem, distributions of the sample mean and the sample variance for a normalpopulation.
- **Estimation**: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for properties, problems.
- **Testing of Hypotheses**: Null and alternative hypotheses, the critical and acceptance regions, two types of errors, power of the test, the most powerful test and Neyman-Pearson fundamental lemma, tests for one sample and two sample problems for normal population (t, F, Z tests), tests for proportions, Chi-square goodness of fit test and its applications, problems.
- **Regression Analysis**: Simple linear regression (Description of the model, least squares estimation, properties of the least square estimators, confidence interval and hypothesis testing for the model parameters, correlation); Multiple linear regression model (Description of the model, matrix approach of Least squares, properties of the least square estimators, confidence interval and hypothesis testing for the model parameters).
- **Design and Analysis of Experiments**: Analysis of variance (One-way classification of fixed effect model,comparing variances, pair wise comparison), randomized complete block design, Latin square design, random effect models, Factorial design, blocking and confounding, Nested and split plot design, Examplesfrom chemical process.

**References:**

1. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier.
2. J. S. Milton & J. C. Arnold, Introduction to Probability and Statistics, McGraw Hill.
3. D C Montgomery, Design and Analysis of Experiments, Wiley 2014.
4. Alexander Mood, Franklin Graybill D. Boes, Introduction to the theory of Statistics, McGraw Hill.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | Engineering Thermodynamics | 3-1-0 | 4 |

Properties of a pure substance, p-v, p-T, T-s and h-s diagrams
Steam generators: Classification, study of fire tube and water tube boilers, Boiler mountings and accessories, boiler efficiencies, equivalent evaporation, Boiler draught, natural and artificial draught, forced, induced and balance draught
Analysis of Power Generation Cycles Air-standard Power Cycles, Concept of Carnot Cycle, Otto Cycles Diesel Cycle, Dual Cycle, Brayton Cycle, Efficiency and Mean Effective Pressure and Temperature, Vapor Power Cycles, The Rankine Cycle, Effect of Temperature and Pressure on The Rankine Cycle, The Superheat Cycle, The Reheat Cycle, The Regenerative Cycle, Deviation of Actual Cycle from Ideal Cycles.
Fuels and Combustion: Types of fuels, calorific values of fuels and their determination, combustion equations, flue gas analysis, Orsat apparatus, excess air, determination of actual quantity of air from combustion analysis
Analysis of Refrigeration Cycles Air-standard Cycles, Joule Cycle. Introduction to Refrigeration Systems -- Vapor-compression Refrigeration Cycle, Vapor-absorption Cycle.
Internal Combustion Engines: 2-S and 4- S Diesel and Petrol Engines, Principles of working of 2- S and 4-S I C Engines.

**Reference:**

Cengel, Y.A., Boles, M.A. and Kanoğlu, M., 2011. Thermodynamics: an engineering approach (Vol. 5, p. 445). New York: McGrawhill
Nag, P.K., 2013. Engineering thermodynamics. Tata McGraw-Hill Education.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | Heat Transfer | 3-1-0 | 4 |

Introduction, Modes of heat transfer, thermal conductivity, combined modes of heat transfer, concept of thermal contact resistance. Derivation of heat conduction equation, steady state one-dimensional heat conduction with and without generation of heat in simple geometries: plane wall, cylindrical and spherical walls, critical thickness of insulation, heat transfer from extended surfaces, 2D steady state heat conduction
Unsteady conduction: lumped heat capacity system, transient heat conduction in infinite and semi-infinite walls, concept of Heisler chart and Schmidt plot, heat conduction from a moving heat source.
Forced convection: Derivation of energy equation, concept of thermal boundary layer and derivation of thermal boundary layer equation, flat plate in parallel flow (solution by energy integral method), cylinder in cross flow, internal flows: concept of thermally fully developed flow and its corollaries, fully developed pipe flow, fully developed channel flow with constant wall heat flux and viscous dissipation, turbulent flow in pipes, Reynolds analogy.
Free convection: Vertical plate at constant temperature â derivation of governing equation, recognition of dimensionless terms, and solution by integral method, free convection in vertical channel. Condensation and Boiling: laminar film condensation over a vertical plate and horizontal circular tube. regimes of boiling heat transfer, correlations for heat flux in boiling.
Heat exchangers: classification of heat exchangers, overall heat transfer coefficient, concept of fouling factor, LMTD and NTU methods of analysis for a double pipe heat exchanger, applications to multi-tube, multi-pass heat exchangers.
Thermal radiation: Radiation properties, blackbody radiation, Planck's law, Stefan Boltzman law, Kirchhoff's law, radiation exchange between black surfaces, concept of view factor, radiation exchange between non-black surfaces, two surface enclosure, three surface enclosure, concept of radiation shield.

**Reference Book**:

1. Bergman, T.L., Lavine, A.S., Incropera, F.P. and DeWitt, D.P., 2011. Introduction to heat transfer. John Wiley & Sons.
2. Heat Transfer by J. P. Holman

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | **Kinematics and Dynamics of machines** | 4-1-0 | 4 |

Kinematics of particles: Kinematics of rigid bodies, instantaneous center of rotation, kinematics in rotating frames and relative motion. Plane kinetics of rigid bodies: Linear and angular momentum, equations of motion, work-energy relation, impulse-momentum relation, conservation laws. Introduction to spatial dynamics of rigid bodies: Kinematics in rotating frames and relative motion, angular momentum, kinetic energy, equations of motion, special cases of parallel-plane motion, and gyroscopic motion.

Introduction to mechanisms: kinematic pairs, kinematic diagrams, classification of kinematic chains, kinematic inversions, and equivalent linkages. Kinematic analysis of planar mechanisms: mobility analysis and range of movement, Grashof criterion and inversions, displacement analysis, relative instantaneous centers, Aronhold-Kennedy theorem, velocity and acceleration analysis. Dimensional synthesis of planar mechanisms: three position synthesis for function generation, path generation and rigid body guidance, dead center problems, branch and order defects.

Cams: synthesis of translating flat-face, translating roller and oscillating roller follower cams. Gears: fundamental law of gearing, characteristics of involutive action, analysis of gear trains. Spatial kinematic chains and robot kinematics: kinematic analysis of spatial chains, Denavit-Hartenberg parameters, robot kinematics.

Reference:

Vinogradov, O., 2000. Fundamentals of kinematics and dynamics of machines and mechanisms. CRC press.

Uicker, J.J., Pennock, G.R., Shigley, J.E. and Mccarthy, J.M., 2003. Theory of machines and mechanisms (Vol. 768). New York: Oxford University Press.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | **Fluid Machines** | 3-0-0 | 3 |

Classification of fluid machines, Positive displacement machines,

Introduction to Turbomachines. Classification of Turbomachines. Second Law of Thermo dynamics - turbine/compressor work, Nozzle/diffuser work. Fluid equations - continuity, Euler's, Bernoulli's equation and its applications. Expansion and compression processes, Reheat Factor, Preheat Factor.

Euler's Equation of Energy Transfer, vane congruent flow, influence of relative circulation, thickness of vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje's slip factor. Suction pressure and net positive suction head. Phenomena of cavitation in pumps. Concept of specific speed, Shape number. Axial, Radial and Mixed Flow Machines. Similarity laws.

Flow through Axial flow fans. Principles of Axial fan and propeller. Application of fans for air circulation and ventilation. Stage pressure rise and work done. Slip stream and Blade Element theory for propellers. Performance and characteristics of Axial fans.

Flow through Centrifugal compressors. Stage velocity triangles, specific work. forward, radial and backward swept vanes. Enthalpy entropy diagram, degree of reaction, slip factor, efficiency. Vane less and vaned diffuser systems, volute as spiral casing. Surge and stall in compressors

Axial turbine stages, stage velocity triangles, work, efficiency, blade loading, flow coefficient. Single stage impulse and reaction turbines, degree of reaction, 50% reaction turbine stage, Radial equilibrium and Actuator disc approach for design of turbine blades. Partial admission problems in turbines. Losses in turbo machines.

Water turbine: Types of turbines: Pelton, Francis, Kaplan, Cross Flow, working Principles, Components and Their Functions, Specific speed, Design, Efficiency, Characteristics and application Governor Principle.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | **Fluid Flow Lab and Design** | 0-0-3 | 2 |

- Bernoulli s experiment; Flow through square and circular pipes; horizontal nozzles; pipe fittings; V-notch,Venturi meter, orifice meter; rotameter; pitot tube; Pipe flow Viscometer; Characteristics of centrifugal pump.
- Two phase flow.
- Design studies on valves, pipe fittings and piping network.
- Mechanical design of pressure vessel, flange, reinforcement for opening, support.

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| ME | **Material Testing Lab** | 0-0-3 | 2 |

1. Hardness Test: Estimating the Hardness of different Engineering materials using Brinell‟s & Rockwell Hardness Testers.
2. Impact Test: Determining the impact strength of a given material using Charpy & IZOD tests.
3.Torsion Test
4. Tension Tests using Universal Testing Machine: Tension test on the given specimens (at least 2 materials for comparison) and to plot the stress strain graphs.
5. Compression Tests using Universal Testing Machine: Compression test on the given specimens and to plot the stress strain graphs
6. Bending and Double Shear Tests using Universal Testing Machine: Bending test, Double Shear test on the given specimens and to plot the stress strain graphs.

# M.Tech course content details:

## Semester I

| Course Code: CH 51001 | MATHEMATICAL METHODS IN CHEMICAL ENGINEERING | Credits 3-0-0: 3 |
|---|---|---|

**Pre-Requisites:** Course on Engineering Mathematics at Undergraduate Level

**Objective**:

This course is designed to impart knowledge of advanced mathematical techniques applicable for solving Chemical Engineering problems.

**Course Outcomes:**

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

1. Formulate and solve eigenvalue problems and their stability aspects.
2. Understand and solve homogeneous and non-homogeneous partial differential equations analytically.
3. Appreciate the approximations in various transport equations and solve using similarity/ integral method

**Syllabus:**

**Introduction of vector space** metric, norm, inner product, onto, into, one to one function, completeness of space. Linear combination of vectors, dependent/independent vectors, orthogonal and orthonormal vectors, gram-schmidt orthogonalization. Matrix, determinants and properties.
**Eigenvalue problem:** Various theorems; solution of a set of algebraic equations; solution of a set of ordinary differential equations; solution of a set of nonhomogeneous first order ordinary differential equations (ivps), applications of eigenvalue problems: stability analysis; bifurcation theory
**Differential Equations:** Classification of equations; Boundary conditions; Principle of Linear superposition, Special ODEs and Adjoint operators: Properties of adjoint operator; Sturm Liouville theorem for eigenvalues and eigenfunctions.
**Solution** of linear, homogeneous PDEs by separation of variables: Cartesian coordinate system & different classes of PDEs; cylindrical coordinate system; spherical coordinate system; Solution of PDEs by different methods, Solution of PDEs by Similarity solution method, Solution of PDEs by Integral method

**Transformations:** Solution of PDEs by Laplace transformation, Solution of PDEs by Fourier transformation

Applications to different chemical engineering processes.

**Text books:**

1. Mathematical Methods in Chemical Engineering by S. Pushpavanam, Prentice Hall of India, 1998.
2. Applied Mathematics in Chemical Engineering by Norman W. Loney, CRC Press, 2016.

**Reference books:**

1. Applied Mathematics and Modeling for Chemical Engineers by R. G. Rice & D. D. Do, Wiley, 1995.

| **Course Code:** **CH 51002** | **ADVANCED TRANSPORT PHENOMENA** | **Credits** **3-0-0: 3** |
|---|---|---|

**Pre-Requisites:** Courses on Momentum, Heat and Mass Transfer at Undergraduate Level

**Objective**:

The objective of this course is to cover advanced topics in this area like the transport of momentum, heat and mass in turbulent flow, creeping flows, flow through porous media, flow over flat plates and curved surfaces, interphase transport, etc. A balanced overview and fundamental equations for transport processes would be provided along with illustrations regarding solving relevant problems.

**Course Outcomes:**

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

1. Apply the shell balance approach to derive differential mass and heat balance equations in Cartesian, cylindrical, and spherical coordinates
2. Apply the generalized differential mass and heat balance equations and the Navier-Stokes equations to analyze transport problems
3. Analyze transport problems in simple geometries and derive analytically the concentration, temperature or velocity distribution

4. Analyze transport problems in complex geometries and calculate numerically the concentration, temperature, or velocity distribution using a simulation software
5. Apply the concept of transfer coefficients to describe mass and heat transfer across interfaces

**Syllabus:**

1. Review of vectors and tensors; Review of basic transport processes; Phenomenological theory – introduction, Eulerian and Lagrangian approaches, equations of integral and differential forms.
2. Reynolds transport theorem; Constitutive relations – Newtonian and non–Newtonian fluids; Momentum transfer – Laminar and turbulent velocity profiles, shear stress and pressure drop in steady, Navier Stokes equations, time smoothed equations for turbulent flow.
3. Fundamentals of boundary layer theory – on flat plate and on an obstacle, turbulent boundary layer, exact solutions of the boundary layer equations for various flows.
4. Heat transfer – temperature profiles in laminar and turbulent flows, Graetz problem, conduction profiles in solids, steady and unsteady free convection, thermal boundary layers – equations for temperature field; time smoothed equations and analogy with momentum transfer.
5. Shell balances of mass species diffusion under various driving forces, diffusion with chemical reaction, convective diffusion in dilute solutions, integral balances in momentum, heat and Mass Transfer.
6. Concentration Distributions in Solids/Laminar Flow; Equations of Change Multicomponent Systems, Concentration Distributions under multiple variable

**Text Books**

1. Bird,R.B., Stewart, W.E. and Lightfoot, E.W. Transport Phenomena Wiley 1994.

2. Robert S.Brodkey, Harry.C.Hershey. Transport Phenomena-A unified approach McGraw Hill Int.Ed.1988.

3. John C.Slattery, Advanced Transport Phenomena, Cambridge University Press -1999.

| Course Code: | PROCESS CONTROL AND AUTOMATION | Credits |
|---|---|---|
| CH 51003 | | 3-0-0: 3 |

**Pre-Requisites:** Course on Process Control at Undergraduate Level

**Objective**: This course is intended to provide a comprehensive knowledge of different control schemes for efficient operation of chemical processes. Practical implementation through PLC and DCS will also be taught.

**Course Outcomes:**

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

1. Design regulatory control scheme for a given process
2. Analyze multivariable processes
3. Apply linear and nonlinear model predictive control
4. Understand PLC and DCS.

**Syllabus:**

- Introduction to control - Hierarchy of control layers, review of basics. System linearization; state space and transfer function models. PID controller design methods.
- Advanced regulatory control schemes - Cascade control, feed-forward control, ratio control, split-range control, time delay compensator, and inverse response compensator.
- Multivariable control - Challenges; Control pairing; Interactions in closed-loop systems; Relative Gain Array (RGA) and variants. Centralized, decentralized, decoupled control schemes. Directionality.
- Model Predictive Control (MPC) - Concepts; Theory and implementation; Relation with LQ-control. Implementation of MPC, State update and model prediction. Receding Horizon implementation; Issues and Challenges.
- Introduction, Data loggers, Data Acquisition Systems (DAS), Supervisory Control and Data Acquisition Systems (SCADA), Piping and Instrumentation Diagrams (P&ID).
- Programmable logic controller (PLC) – overview, General PLC programming procedures, Introduction to Distributed control systems (DCS).

**Text Books:**

1. Process Dynamics and Control, Seborg, D. E., Edgar, T. F., Millechamp, D. A., Doyle III, F. J., Wiley, 2014, 3rd Edition.

2. Process Control Fundamentals: Analysis, Design, Assessment, and Diagnosis, Raghunathan Rengaswamy, Babji Srinivasan, Nirav Pravinbhai Bhatt, CRC Press, 2020.

3. Model Predictive Control System Design and Implementation using MATLAB, Liuping Wang, Springer, 2009.
4. Industrial Automation using PLC, SCADA and DCS, Jamkar, R. G., Global press, 2018.

**Reference Books:**

1. Predictive Control for Linear and Hybrid Systems, Francesco Borrelli, Alberto Bemporad, Manfred Morari, Cambridge University Press, 2017.

2. Process Control: Theory and Applications, Jean-Pierre Corriou, Springer, 2018, Second Edition.
3. Process Dynamics and Control, B. Roffel and B. Betlem, Wiley, 2006.
4. Introduction to Programmable logic controller, Dunning, G. A., Cengage Learning, 2005.

| **Course Code:** | **CHEMICAL ENGINEERING LAB** | **Credits** |
|---|---|---|
| **CH 51004** | | **0-0-3: 2** |

**Pre-Requisites:** Basic knowledge in Chemical engineering

**Objective**:

The objective of the course is to provide insight into the basic tasks, methods and tools in chemical engineering by laboratory experiments.

**Course Outcomes:**

At the end of the course, the student will be able to acquire practical experience in the application of the knowledge and the methods that are taught in the lectures and tutorials and improve their ability to solve typical problems in chemical engineering and to systematically tackle complex tasks in small groups.

**Syllabus:** Ten experiments from various chemical engineering laboratories. The results of the experiments have to be documented during the experiments.

## Semester II

| Course Code: | CHEMICAL REACTOR DESIGN | Credits |
|---|---|---|
| CH 52001 | | 3-0-0: 3 |

**Prerequisites:** Basics of chemical reaction engineering

**Objective**:

To learn about reaction kinetics for single, multiple, isothermal, non-isothermal reactions and reactor design procedures

**Course Outcomes:**

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

1. Able to analyze chemical reactors and reaction systems
2. Design experiments involving chemical reactors, and analyzing and interpreting data
3. Ability to solve problems of mass transfer with reaction in solid catalyzed reactions
4. Design and sizing of industrial scale reactor on the basis of kinetic data obtained at lab scale

**Syllabus**

**Chemical reaction mechanisms and kinetics*:*** Review of reaction kinetics and ideal reactors, stoichiometry, thermodynamics of reacting systems, catalytic reactions, non-catalytic reactions.

**Non-isothermal reactors:** Isothermal/Non isothermal steady state and Unsteady state operations. Multiple steady state analysis.

**Non-ideal reactors*:*** Principles of non-ideal flow, RTD, Models for non-ideal flow patterns, tanks in-series.

**Multiphase reactor design*:*** Gas-Solid and Liquid-Solid Catalytic Reactions: Gas-solid reactions, Liquid-solid reactions, Reactors for Biological Waste Treatment. Multiphase reactors, Fluidised bed reactors; Packed Bed Reactors.

**Design and Development of Heterogeneous Catalysts**: Effects of External diffusion on heterogeneous reactions, Diffusion and reaction in different shape porous catalysts (cylindrical, cubic and spherical), Falsified Kinetics.

**Text Books:**


1. Levenspiel O, Chemical Reaction Engineering, 3rd Edition, Wiley India (1999)
2. Fogler S H, Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall India (2015).
3. J. M. Smith,Chemical Engineering Kinetics, McGraw Hill 1981.
4. K. R. Westerterp, W. P. M. Van Swaaij and A. A. C. M. Beenackers, Chemical Reactor Design and Operation by Wiley Blackwell 1987.


**Reference Books:**


5. Schmidt L D, The Engineering of Chemical Reactions, 2nd Edition, Oxford University Press (2005).

6 .Froment G F and Bischoff K B, Chemical Reactor Analysis and Design, 2nd Edition, John Wiley & Sons (1990)

7. Doraiswamy L K and Uner D, Chemical Reaction Engineering: Beyond the Fundamentals, 1st Edition, CRC Press (2013)


| **Course Code:** CH 52002 | **ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS** | **Credits** 3-0-0: 3 |
|---|---|---|

**Pre-Requisites:** Course on Chemical Engineering Thermodynamics at Undergraduate Level

**Objective:** This course aims at providing thorough knowledge of classical and mixture thermodynamics with specific applications and introduces basic concepts of statistical thermodynamics and quantum mechanics.

**Course outcomes:**

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

1. Apply classical thermodynamics principles for real fluids
2. Understand the statistical approach and apply for property estimation
3. Appreciate the molecular perspective of equilibrium states

**Review of classical approach:** Introduction to thermodynamics and statistical mechanics; Laws of thermodynamics; PVT relations; Legendre transforms of energy; Property estimation; Maxwell relations; Phase equilibrium.

**Statistical approach:** Microcanonical, canonical and grand-canonical ensembles; Gibb's entropy formula and Boltzmann entropy formula; Partition functions; Fluctuations and stability; Probability postulate; Ergodic hypothesis, Molecular interactions and force-fields.

**Mixture thermodynamics:** Partial molal properties; Fugacity; Excess Gibb's free energy and activity coefficients; Using suitable models for property estimation; Equilibrium and stability analysis

**Quantum mechanics:** Schrödinger Wave equation; Degeneracy; Partition functions; Ideal gas of polyatomic particles; Molecular partition functions; Einstein and Debye theory of perfect crystals.

**Text book:**

1. Herbert B. Callen, Thermodynamics and an Introduction to Thermostatistics, John Wiley and Sons, 2nd Edition, 1991.

**Reference books:**

1. David Chandler, "Introduction to modern statistical mechanics", Oxford University Press, 1987.

2. Stanley I. Sandler, Chemical, Biochemical, and Engineering Thermodynamics Wiley, 4th Edition, 2006

| **Course Code:** CH 52003 | **MACHINE LEARNING IN PROCESS ENGINEERING** | **Credits** 3-0-0: 3 |
|---|---|---|

**Pre-Requisites:** Undergraduate Mathematics

**Objective:** This course Provides motivation and understanding of the need and importance of Machine Learning in today's world. This course will Impart knowledge about role of machine learning in process engineering

**Course Outcomes:**

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

1. Demonstrate proficiency with statistical analysis of data
2. Use inferential statistics for decision making
3. Apply supervised learning for classification and regression problems
4. Apply unsupervised learning for clustering

**Syllabus:**

Introduction to data analytics, Python fundamentals.

**Data Quality and Pre-processing:** Distance measures, dimensionality reduction, principal component analysis (PCA).

**Descriptive Statistics:**

Graphical approach - Frequency tables, relative frequency tables, grouped data, pie chart, bar chart, histograms, ogives, stem and leaf plots, box plots, dot diagram, scatter plots, Pareto diagram.

Measure of Central Tendency and Dispersion - Arithmetic mean, median and mode, variance, standard deviation, quartiles, range, mean absolute deviation, coefficient of variation, Z scores, normal distribution, confidence interval estimation.

**Probability Distribution and Inferential Statistics:** Random variables, probability distributions, hypothesis testing, single sample test, two sample test, Type I error, Type II error, Analysis of Variance (ANOVA).

**Supervised learning:** Linear regression, ridge regression, Lasso regression, logistic regression, multiple linear regression, goodness of fit, bias–variance trade off, k-nearest neighbors algorithm, linear discriminant analysis, classification and regression trees and pruning, support vector machines, random forest, Naive Bayes, Introduction to deep learning.

**Unsupervised learning:** Cluster analysis – K Means, hierarchical, DBSCAN. Applications to different chemical engineering systems.

**Text Books:**

1. Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th Edition, John Wiley & Sons Inc., 2016.

2. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, Jerome Friedman, 2nd Edition, Springer, 2009.

3. Introduction to Machine Learning, Ethem Alpaydın,3rd Edition, MIT Press, 2014

**Reference Books:**

1. A General Introduction to Data Analytics, João Mendes Moreira , André C. P. L. F. de Carvalho, Tomáš Horváth, Wiley, 2019.

2. Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, 2nd Edition, Pearson, 2019.

| **Course Code:** | **PROCESS SIMULATION LAB** | **Credits** |
|---|---|---|
| **CH 52004** | | **0-0-3: 2** |

**Pre-Requisites:** Basics of linear algebra, calculus, numerical techniques, and chemical engineering principles.

**Objective**: Introduce computational techniques using process simulation softwares such as MATLAB, SIMULINK and ASPEN with unit process and operation examples.

**Course Outcomes:**

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

1. Code in MATLAB and run & analyze simulations on SIMULINK & ASPEN

2. Solve various chemical engineering model problems by computation techniques

3. Design of unit processes and operations in the chemical industry

**Syllabus:**

**Introduction to computation methods in chemical engineering**: Background of matlab, Solving Linear and Nonlinear equations

**Application of Calculus and Optimization in chemical engineering**: Solving ordinary differential equations and partial differential equations, Regression and Optimization

**Introduction to MATLAB Simulink:** Block diagram construction and simulation of chemical engineering systems

**Pure component property analysis and VLE/LLE calculations:** Txy-Pxy plots, Computation of VLE data using (i) ideal mixture assumption and (ii) using various activity coefficient models such as Wilson, Van-Laar model, UNIFAC etc.

**Unit operations and Unit process calculations by Aspen:** Distillation, Heat exchangers, Reactor-separator problems: reflux, recycle ratio, product purity, yield etc

**Real case studies**: Construction of real chemical industry plant and simulation

**Text books:**


1. N. Kaisare, Computational techniques for process simulation and analysis using Matlab. CRC Press (2017).
2. Introduction to Chemical Engineering Computing, Second Edition by Bruce A. Finlayson (2006).
3. Numerical Methods for Engineers 7th Edition by Steven C. Chapra and Raymond P. Canale (2015).


**Reference books:**


1. S.K. Gupta, Numerical Methods for Engineers. New Age International Publishers (2015).
2. R.G.E. Franks, Modeling and simulation in chemical engineering, Wiley Blackwell (1972).
3. Kamal l. M. Al-Malah Aspen Plus: Chemical Engineering Applications, Wiley (2016).


# Electives

**Electives - I, II & III**

| Course Code:<br><br>CH 51020 | MULTIPHASE FLOW | Credits<br><br>3-0-0: 3 |
|---|---|---|

**Objective**

Make the student familiar with the effects of bubbles, droplets or solid particles on the flow of a liquid in nature and industrial processes.

**Course Outcomes:**

At the end of the course the student should know how to classify the various different multiphase flows and know how to determine which mechanisms are at play for various different conditions which occur in natural processes and industry.

**Syllabus:**

1. Introduction to multiphase flow, types and applications, Common terminologies, flow patterns and flow pattern maps,
2. Flow past immersed bodies: Drag and drag coefficients, flow through beds of solids, motion of particles through fluids, fluidization, types of fluidization and applications.
3. Two-phase flow: Hydrodynamics of Gas-liquid flow, Two–phase flow through pipes. Interaction of fluids: Mixing of a single fluid; degree of segregation, early and late mixing of fluids, models for partial segregation, mixing of two miscible fluids. Gas-liquid flow phenomenon
4. Multiphase Interactions: Drag, lift, virtual mass force, Basset force, one way, two way, three-way and four-way coupling and mathematical formulation of the same.
5. Modelling Methods for Multiphase Flows: Mixture Model, Euler-Euler Model and Euler-Lagrangian Model
6. Multiphase Reactors: Bubble Column, Packed Bed, Fluidized Bed
7. Measurement Techniques used in Multiphase Flows

**Text books:**

1. One dimensional Two Phase Flow by G. B. Wallis.

2. Measurement of Two Phase Flow Parameters by G.F.Hewitt.

3. Flow of Complex Mixtures by Govier and Aziz.

4. Two Phase Flow by Butterworth and Hewitt.

5. Handbook of Multiphase systems by Hetsroni.

| Course Code: CH 51021 | PROCESS OPTIMIZATION | Credits 3-0-0: 3 |
|---|---|---|

**Pre-Requisites:** Mathematics

**Objective:** Provide in-depth knowledge of various techniques of optimization and their application to chemical processes

**Course Outcomes:**

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

1. Formulate objective function for a given problem
2. Solve unconstrained single and multi-variable optimization problems
3. Apply linear programming and nonlinear programming techniques
4. Apply optimization methods on chemical and biochemical processes

**Syllabus:**

**Introduction** to Optimization (Statement of optimization problems, Classification of optimization problems, Examples from engineering applications, Review of linear algebra); Optimization Problem Formulation (Models for optimization, Optimization problems in chemical/biochemical engineering)

**Basic Concepts** of Optimization – I (Continuity of functions, Unimodal and multimodal functions, Optimality criteria for unconstrained single variable functions)
Basic Concepts of Optimization – II (Optimality criteria for unconstrained multivariable functions, Equality constrained problems, Lagrange multipliers, Kuhn Tucker conditions)

**Unconstrained Single Variable Optimization:** Methods and Applications (Region elimination methods, Methods requiring derivatives: Newton-Raphson method, Bisection method, Secant method)

**Unconstrained Multivariable Optimization:** Direct Search Methods (Simplex method, Hooke-Jeeves pattern search method, Powell's conjugate direction method)

Unconstrained Multivariable Optimization: Gradient Based Methods (Cauchy's method, Newton's method, Marquardt method)

**Introduction to Linear Programming** (Formulation of linear programming models, Graphical solution, Linear programs in standard form)
Linear Programming: The Simplex Method (Simplex method, Use of artificial variables, Two phase method)
Constrained Nonlinear Programming (Penalty function method, Lagrange multiplier method)
Applications of Optimization (Optimization of various chemical and biochemical processes) (MATLAB)

**Text Books:**

1. Optimization of Chemical Processes – T. F. Edgar, D. M.Himmelblau and L. S. Lasdon, 2nd Edition, McGraw Hill, 2001.
2. Engineering Optimization: Methods and Applications - A. Ravindran, K. M. Ragsdell, G. V. Reklaitis, 2nd Edition, Wiley India, 2006.,
3. Engineering Optimization: Theory and Practice - S. S. Rao, 4th Edition, John Wiley & Sons, Inc, 2009.
4. Optimization: Theory and Practice, Mohan C. Joshi and Kannan M. Moudgalya, Alpha Science International Limited, 2004.
5. Convex optimization, Stephen Boyd, Lieven Vandenberghe, Cambridge University Press, 2004.
6. Applied Optimization with MATLAB Programming, Venkataraman P., Wiley, 2009, 2nd Edition.

| **Course Code:** | **ADVANCED SEPARATIONS** | **Credits** |
|---|---|---|
| **CH 40004** | | **3-0-0: 3** |

**Pre-Requisites:** Basic knowledge in Mass Transfer and Transport phenomena

**Objective**:

To impart understanding of various aspects of novel separation systems considering application, theory and design. Learn to develop design equations for various filtration processes.

**Course Outcomes:**

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

1. Evaluate the design parameters for multicomponent distillation process

2. Identify and model suitable membrane process for treatment of target contaminants

3. Understand specific applications of novel separation process

**Syllabus:**

1. **Advanced Distillation Processes:** Review of Distillation; Steam Distillation; Complex Distillation Processes; Azeotropic Distillation; Homogeneous and Heterogeneous Systems; Pressure Swing distillation; Extractive Distillation with Entrainers; Multicomponent Distillation: Approximate method, Rate Based Method, Equation Tearing Procedure.
2. **Membranes separation processes for gas mixtures:** Membrane Structures, Transport across membranes, Different configurations of membranes, Modeling aspects: product purity and yield;
3. **Membranes separation processes for liquids:** Microfiltration, ultrafiltration, Nanofiltration, Cross-flow, Batch Cell, Module design. Introduction, Theory, Design of Dialysis, Liquid Membranes, Pervaporation and Reverse Osmosis.
4. **Other Separation Processes**: Adsorption (PSA, TSA, advanced processes, modeling), Ion Exchange, Chromatography; Centrifugal separation, Electrophoretic separation, Micellar enhanced separation.

**Text Books:**

1. J. D. Seader and E.J. Henley, Separation Process Principles, Wiley (2006).

2. R.W. Baker, Membrane Technology and Applications, Second Edition, Wiley (2004).

**Reference Books:**

1. Charles Holland, Fundamentals of Multicomponent Distillation, McGraw Hill (1997)

| **Course Code:** | **SOLAR ENERGY, PHOTOVOLTAIC ENERGY** | **Credits** |
|---|---|---|

| | | |
|---|---|---|
| **CH 40010** | | **3-0-0: 3** |

**Objective**: The course provides a thorough understanding of different aspects of solar energy and also photovoltaic cells and their applications.

**Syllabus:**
Introduction; Nature and availability of solar energy; Principle of operation of solar cells-materials and processing, thin film, unconventional materials and systems; Concentrators; Cells and system characteristics; Power conditioning, energy storage, and grid connection; Maximum power point tracking, PV to grid – single and three phases; Economy and Life cycle costing.
Solar thermal energy.
Water pumping: dc and ac pump drive; Peltier refrigeration.

**Text/Reference Books:**
1. Hans S. Rauschenbach, Solar Cell Array Design Handbook: The Principles and Technology of Photovoltaic Energy Conversion. Springer (2013).
2. C. Hu and R.M. White, Solar Cells: From Basic to Advanced Systems. McGraw Hill (1983)

| **Course Code:** | **WASTE TO ENERGY CONVERSION** | **Credits** |
|---|---|---|
| **CH 51022** | | **3-0-0: 3** |

**Pre-Requisites:** Basic of heat, thermodynamics, and chemical reaction engineering, Biochemical processes

**Objective**: The course provides a thorough understanding of waste to energy resources, technologies and systems to convert the waste into energy (e.g., anaerobic digestion, fermentation, pyrolysis, gasification, incineration, etc.). It also provides a basic understanding of the principles underlying the modern design and operation of systems based on recent research.

**Course Outcomes:**

1. Understand and learn the fundamental aspects involved during the conversion of waste into energy (e.g., anaerobic digestion, fermentation, pyrolysis, gasification, incineration, etc.).
2. Be familiar with the current research scenario associated with biochemical and thermal treatment of wastes & biomass.

3. Acquired skills will be useful in the preparation, planning, and implementation of energy projects.

**Syllabus:**

1. **Introduction to energy from waste:** Characterisation and classification of waste as fuel agro-based, forest residues, industrial waste, municipal solid waste.
2. **Waste to energy options**: Biochemical and Thermochemical routes; Biochemical Options – Anaerobic Digestion, Fermentation; Thermochemical Options – Pyrolysis, Gasification, and Incineration; Other options – Biodiesel synthesis, Briquetting, Torrefaction, and Hazardous waste management.
3. **Properties of fuels derived from waste to energy technology:** Producer gas, Biogas, Ethanol, and Briquettes, Comparison of properties with conventional fuels.
4. **Other alternate option and Heat and mass balance:** Energy production from waste plastics, Cultivation of algal biomass from wastewater and its application in energy production. Calculations: heat & mass balances
5. **Landfills:** Gas generation and collection in landfills, Introduction to transfer stations.

**Text Books:**


1. M.M. EL-Halwagi, Biogas Technology, transfer and diffusion, Elsevier Applied science Publisher, New York (1984).
2. D.O. Hall and R.P. Overeed, Biomass-Renewable Energy, John Willy and Sons, New York (1987).
3. J.H. Harker, and J.R. Backhusrt, Fuel and Energy, Academic Press Inc
4. M.J. Rogoff, and F. Screve, Waste-to-Energy: Technologies and Project Implementation, Elsevier Store.


| **Course Code:** | **INTERFACIAL SCIENCE** | **Credits** |
|---|---|---|
| **CH 51023** | | **3-0-0: 3** |

**Pre-Requisites:** Fundamentals of Fluid flow and transport processes

**Objective:** This course will introduce the origin and significance of interfacial interactions and their applications that includes drop dynamics, capillary action and colloidal stability.

**Course outcomes:**

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

1. Understand the effects of surface forces and their significance
2. Modeling aspects of surface forces and hydrodynamics
3. Understand colloidal stability and its implications

**Intermolecular and surface forces:** Introduction; van der Waals forces; Electrostatic double layer force; Disjoining pressure; DLVO theory

**Two-phase flow:** Introduction; Definition of surface tension and its scaling, Young's law and its relevant applications on bubbles and drops, Stress boundary conditions, Marangoni flows highlighting thermocapillary stresses, Thermocapillary migration of bubbles and drops and its applications. Dynamics of hollow drops: upcoming area of research.

**Engineering of interfaces:** Occurrence of interfaces in science and engineering; Overview of industrial applications of various interfacial phenomena.

**Colloidal materials**: Properties of colloidal systems; Experimental characterization of colloidal dispersions. Hydrodynamics of a free surface, Capillarity, Physical origin of Instability, Wetting and dewetting, Length Scales, Analysis.

**Text Books:**

1. Stokes, R. J. and Evans, D. F., Fundamentals of Interfacial Engineering, Wiley-VCH, New York, 1997.

**Reference Books:**

1. Israelachvili, J., Intermolecular and Surface Forces, Academic Press, London, 1992.
2. Edwards, D.A.,Brenner, H. and Wasan, D. T., Interfacial Transport Processes and Rheology,ButterworthHeinemann,Boston, 1990.

| **Course Code:** | **SURFACE ENGINEERING** | **Credits** |
|---|---|---|
| **CH 51024** | | **3-0-0: 3** |

**Objective**:

Design and deploy various coatings that meet the needs of individuals and the industries.

**Course Outcomes:**

At the end of the course:

1. The student will be able to understand: Principles of coating deposition and surface modification methods - Fundamental coating properties and their relationship - Introduction to corrosion and wear protection, and various functionalities obtainable by coatings and surface treatments.

2. Students have comprehensive background for understanding various manufacturing processes of engineering coatings and surface treatments, structure and properties of coatings, and their industrial use in technical applications.

**Surface Engineering:** Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coatings.

**Chemical Vapour Deposition**: Mechanisms, important reactions involved, Process parameters and applications.

**Physical Vapour Deposition:** Vacuum Evaporation Deposition, Reactive Evaporation Deposition, Cathodic Arc Evaporation Deposition, Sputtering, Radio Frequency and Pulsed DC sputtering, Sputter Deposition of Nitride Coating, Sulphide Coating

**Surface Coating by Wetting:** Mechanism of Wetting, Coating on Ceramics by Wetting, Coating of Monolayer Abrasive grain by Wetting

**Characterization of Coating:** Physical Characterization, Assessment of coating hardness, friction, surface roughness and thickness, Assessment of Adhesion of Coating, Surface chemistry.

**Different methods for surface modification:** Surface modification by use of directed energy beams, Plasma, Sputtering & Ion Implantation.

**Text Books:**

1. J. R. Davis-Surface Engineering for Corrosion and Wear Resistance.

2. George J. Rudzki -Surface Finishing Systems. metal and non-metal finishing handbook-guide, Metals Park : ASM, 1983

3. James A. Murphy- Surface Preparation and Finishes for Metal, McGraw-Hill, New York 1971

4. P. G. Sheasby and R. Pinner - Surface treatment and finishing of Aluminium and its alloy,Volume-2, 5th ed., ASM, Metals Park, 1987

5. Surface Engineering Hand Book, edited by Keith Austin, London : Kogan Page, 1998

| Course Code: | PROCESS INTENSIFICATION | Credits |
|---|---|---|
| CH 51025 | | 3-0-0: 3 |

**Pre-Requisites:** B.Tech. in Chemical Engineering

**Objectives:** Covers the developments in a number of intensified technologies, with particular emphasis on their application in chemical processes. Provide a basic knowledge of chemical engineering principles and process intensification for chemists and engineers who may be unfamiliar with these concepts.

**Course outcomes:**

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

1. Understand the need for process intensification
2. Understand various process intensification techniques
3. Understand and apply process intensification techniques to chemical processes
4. Understand and apply process intensification based on micro-reactors

**Introduction:** Introduction to Process Intensification**:** History, Philosophy and Concept; Mechanisms involved in the process intensification: Intensification by fluid flow process, mixing, Reactive system;

**Role of Process intensification in sustainable development**: Problems leading to sustainable development: Concept, Issues and Challenges, Strategies in process design; Design Techniques for Process Intensifications: Scales and stages of process intensification, Methods and Tools for Achieving sustainable design, Multi-level Computer aided tools

**Process intensification methods:** Process integration by cavitation; Process Intensification by monolith reactor; Interfacial area based PI

**Process intensification in Chemical process equipment:** Process intensification in distillation**;** Process intensification in extraction; Process intensification by membrane

**Micro Process Technology in process intensification:** Introduction to microprocess technology, Process Intensification by Microreactors, Hydrodynamics and transport in microchannel based microreactor

**Text Books:**

1. Kamelia Boodhoo and Adam Harvey. Process Intensification for Green Chemistry Engineering Solutions for Sustainable Chemical Processing, Edited by Kamelia Boodhoo and Adam Harvey , School of Chemical Engineering & Advanced Materials Newcastle University, UK. Willey, 2013.
2. Juan Gabriel Segovia-Hernández, Adrián-Bonilla-Petriciolet Editors, Process Intensification in Chemical Engineering Design Optimization and Control, Springer, 2016.
3. David Reay, Colin Ramshaw, and Adam Harvey, Process Intensification: Engineering for efficiency, sustainability and flexibility, IchemE, 2nd edition, 2013, Elsevier.
4. S. K. Majumder, Hydrodynamics and Transport Processes of Inverse Bubbly Flow, 1st ed. Elsevier, Amsterdam (2016)

## Electives - IV & V

| Course Code: CH 52020 | ENERGY STORAGE AND CONVERSION DEVICES | Credits 3-0-0: 3 |
|---|---|---|

**Pre-Requisites:** Basics of electrochemistry and transport processes

**Objective:** This course will provide in-depth knowledge of different types of energy storage devices, design features and performance. It also introduces various aspects of fuel cells (principles, structural features and applications) as alternatives for sustainable developement.

**Course outcomes:**

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

1. Design battery rating based on power requirement.
2. Understand the advantages and disadvantages of different types of batteries available.
3. Understand the upcoming trends in Fuel cell technology as an alternative energy source.

**Introduction:** Alternative energy sources and sustainability; Introduction to electrochemical energy storage and conversion; Introduction to Supercapacitors; Introduction to Lead acid and

Lithium ion batteries, Introduction to fuel cells, Introduction to bio-electrochemical energy conversion systems

**Lead acid batteries:** Lead acid batteries: Flat plate and Tubular batteries; Key components and features; Design of power rating and charging current calculations; Testing and performance curves

**Lithium-ion batteries:** Basic components and characteristics of Lithium ion cells; Introduction to battery bank design; Supercapacitors; Other types of batteries

**Fuel cells:** Fuel cells: Types of fuel cells; Applications; Polymer electrolyte membrane fuel cells; thermodynamics of fuel cells; Testing and performance curves.

**Renewable energy integration and Applications:** Solar, wind energy Storage aspects; Introduction to electric based transportation; Other applications of ESS

**Text Books:**

1. Energy Storage: Fundamentals, Materials and Applications, by Huggins R. A., Springer
2. O'Hayre, R.P.,S. Cha, W. Colella, F.B.Prinz, Fuel Cell Fundamentals, Wiley, NY (2006)

**Reference Books:**

1. Battery Systems Engineering by C. D. Rahn and C. Wang, Wiley Pub.
2. Bard,A. J. , L. R., Faulkner,Electrochemical Methods, Wiley, N.Y.(2004)
3. Liu, H.,Principles of fuel cells, Taylor & Francis, N.Y. (2006).

| **Course Code:** CH 52021 | **HETEROGENEOUS CATALYSIS SCIENCE AND TECHNOLOGY** | **Credits** 3-0-0: 3 |
|---|---|---|

**Pre-requisites:**

**Objectives:** Heterogeneous catalysis has its wider outreach in fields of chemical engineering especially processes involved in Chemical, Petroleum, Petro-Chemical industries and environmental remediation front. This course is designed to impart the fundamental concepts involving catalytic synthesis, characterization, Kinetic modeling and applications.

**Course Outcome:**

By the end of this course, the student will be familiar with the concepts of:

1. Different Adsorption isotherms encountered in catalytic processes.
2. Reaction mechanism development for different gas phase reactions using various methodologies
3. Different catalysts synthesis protocols involved in heterogeneous catalysis
4. Different Characterization techniques for effective and intuitive understanding of different catalytic materials
5. Application of heterogeneous catalysis in different Chemical, Petroleum and Petro-Chemical Processes.
6. New age heterogeneous catalysts application to different applications.

**Fundamentals of Catalysis:** Introduction, Theories of adsorption, Isotherms- Freundlich, Temkin, BET

**Kinetics:** Reaction mechanism development, rate expression development, Modeling methodologies etc.

**Synthesis Procedures for Catalysis:** Wetness Impregnation, Incipient Wetness Impregnation, Sol-gel Techniques, Precipitation methods etc., for synthesis of different catalysts.

**Characterization techniques for catalysts :**X ray Diffraction, XPS, TEM, SEM, STM, Thermal and Other Temperature-Programmed Methods, , ICP, DRIFTS, FTIR, Raman, GCMS, LCMS, Isotope tracking, etc.

**Applications of heterogeneous catalysis in Industries:** (i) Chemical Industries (ii) Petroleum and Petro-chemicals ,(iii) Environmental Applications,

**Catalysis for other applications:** Photo catalysis, Nano metal and metal oxide based catalysts

**References**


1. Vannice, M. A., & Joyce, W. H. (2005). Kinetics of catalytic reactions (Vol. 134). New York: Springer.

2. Misono, M. (2013). Heterogeneous Catalysis of Mixed Oxides. Elsevier Inc.

3. Thomas, J. M., & Thomas, W. J. (2014). Principles and practice of heterogeneous catalysis. John Wiley & Sons

4. Dumesic, J.A. et al. (1993).The Microkinetics of Heterogeneous Catalysis. ACS professional reference book. Wiley

| Course Code: CH 52022 | COMPUTATIONAL FLUID DYNAMICS | Credits 3-0-0: 3 |
|---|---|---|

**Pre-Requisites:** Fluid mechanics and basics of Transport phenomenon

**Objective**: Introduce computational fluid dynamics along with chemical engineering applications and analysis of fluid mechanics related problems

**Course Outcomes:**

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

1. Apply Finite difference and Finite volume methods in CFD modeling

2.Generate and optimize the mesh

3.Simulate CFD models and analyze the results

**Syllabus**

**Introduction**: Introduction to the CFD approach and Illustration of CFD through a worked out example (triangular and square duct)

**Derivation of equations governing fluid flow**: Eulerian approach, Conservation equations: mass, momentum and heat balance equations, Navier stokes equations, Equations for incompressible flow

**Principles of Solution of the Governing Equations:** Finite difference and Finite volume Methods, Convergence, Consistency, Error and Stability, Accuracy, Boundary conditions, CFD model formulation

**Mesh generation:** Overview of mesh generation, Structured and Unstructured mesh, Guideline on mesh quality and design, Mesh refinement and adaptation

**Solution Algorithms:** Discretization schemes for pressure, momentum and energy equations - Explicit and implicit Schemes, First order upwind scheme, second order upwind scheme, QUICK scheme, SIMPLE, SIMPLER and MAC algorithm, pressure-velocity coupling algorithms, velocity-stream function approach, solution of Navier-Stokes equations**.**

**CFD Solution Procedure:** Problem setup – creation of geometry, mesh generation, selection of physics and fluid properties, initialization, solution control and convergence monitoring, results reports and visualization.

**Case Studies:** Simulation of CFD problems by using Ansys fluent or COMSOL software.

**Text books:**

1. Ferziger, J., and M. Peric, Computational Methods for Fluid Dynamics, Third Ed., Springer, (2001)
2. Niyogi, P. Chakrabarty, S.K. and Laha, M.K., Introduction to computational fluid dynamics, Pearson education (2006)
3. Pletcher, R. H., Tannehill, J. C., and Anderson, D., Computational Fluid Mechanics and Heat Transfer, CRC, (2011)

**Reference books:**

1. Versteeg H.K. & Malalsekera W. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical, Harlow, Essex, UK.(1995)
2. Anderson J.D. Computational Fluid Dynamics: The Basics with Applications,McGraw-Hill, Inc.(1995)

| **Course Code:** | **BIO ENERGY** | **Credits** |
|---|---|---|
| **PE 30014** | | **3-0-0: 3** |

Introduction to Bioenergy; Current status, merits & demerits. Feedstock,: starch, oilseed, lignocellulogic and algae based, fuel logistics of Biomass, Biological conversion technologies, enzyme hydrolysis, ethanol fermentation, comparisons of fossil fuels and biofuels, Fundamentals of anaerobic digestion, Microbial fuel cells, Bio-refinery, Economic, Social and Ecological Impacts of Bioenergy at Local, National and Global Levels, Life cycle assessment, current and emerging challenges to bioenergy development, Govt policies and standards.

Text Books:

1. Y. Li, and S. K .Khanal, Bio Energy: Principles & Applications:, Wiley-Blackwell 2016.

2. S. Lee, and Y T Shah, Bio Fuels and Bio Energy: Processes and Technologies, CRC Press, 2012

| Course Code: CH 30010 | WASTEWATER MANAGEMENT | Credits 3-0-0: 3 |
|---|---|---|

**Pre-Requisites:** Basics of unit operations and processes; Fundamentals of biological processes

**Objective**: The course provides a thorough understanding of wastewater management to convert the "burden (i.e., wastewater)" into "resources (i.e., clean water, energy, and fertilizer).

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

1. Understand categorisation of wastewater, their sources along with various characterization methods
2. Learn the fundamental aspects of physical, chemical, and biological processes for wastewater treatment
3. Convert the "burden (i.e., wastewater)" into "resources (i.e., clean water, energy, and fertilizer) using wastewater management techniques

**Syllabus:**

**Introduction:** Introduction to water and wastewater engineering, Methods for characterizations of wastewater properties.

**Wastewater Treatment Processes:** Physical, chemical and biological process for wastewater treatment, Primary, secondary and tertiary treatment including suspended growth and attached growth methods.

**Advance Oxidations process and sludge treatment:** Advanced oxidations process for removal of recalcitrant components in wastewater, nutrient removal, sludge treatment and its removal

**Zero discharge techniques and standards:** Progress in zero discharge technique, standards and regulations

**Case studies:** Case studies related to treatment of Industrial and municipal effluents

**Text Books:**

1. W. Eckenfelder (Jr.) Industrial Water Pollution Control, McGraw Hill 1999.
2. G. Tchobanoglous, .L. Burton, and H.D. Stensel, Wastewater Engineering Treatment and Reuse (Metcalf & Eddy), McGraw Hill 2002.

**Reference Books:**

1. H.S. Peavy, D. R. Rowe, G. Tchobanoglous, Environmental Engineering, Mcgraw-Hill 1985.
2. A. P. Sincero and G.A. Sincero, Physical-Chemical Treatment of Water and Wastewater, CRC press 2002.

| Course Code: | PROCESS MODELING AND SIMULATION | Credits |
|---|---|---|
| CH 40013 | | 3-0-0: 3 |

**Pre-Requisites:** Engineering Mathematics, Core Chemical Engineering Courses

**Objective:** This course is intended to learn model development using first principles and data in different chemical engineering processes and also to apply numerical methods for solving mathematical models.

**Course Outcomes:**

1. At the end of the course, the student will be able to:
2. Apply conservation laws for different chemical engineering processes
3. Analyse ill-conditionality
4. Solve ODEs, PDEs, DAEs
5. Use different software tools for simulation

**Syllabus:**

Introduction to modeling, a systematic approach to model building, classification of models. Conservation principles, thermodynamic principles of process systems.

Development of steady state and dynamic lumped and distributed parameter models based on first principles. Analysis of ill-conditioned systems.

Development of grey box models. Empirical model building. Statistical model calibration and validation. Population balance models. Examples.

Solution strategies for lumped parameter models. Stiff differential equations. Solution methods for initial value and boundary value problems. Euler's method. R-K method, shooting method, finite difference methods. Solving the problems using *MATLAB/SCILAB.*

Solution strategies for distributed parameter models. Solving parabolic, elliptic and hyperbolic partial differential equations. Finite element and finite volume methods.

**Text Books:**

1. Chemical Process Modelling and Computer Simulation, Amiya K. Jana, Prentice Hall, 2011, 2nd Edition.
2. Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, Ashok Kumar Verma, CRC Press, 2014.

3. Process Modelling, Simulation and control for Chemical Engineers, William L. Luyben, McGraw-Hill Publishing Company, 1996, 2nd Edition.

**Reference Books:**

1. Mathematical Modelling and Simulation in Chemical Engineering, M. Chidambaram, Cambridge University Press, 2018.
2. Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, Ashok Kumar Verma, CRC Press, 2014.
3. Mathematical Modelling: Case Studies, Jim Caldwell, Douglas K. S. Ng, Kluwer Academic Publishers, 2004.
4. Conservation Equations and Modelling of Chemical and Biochemical Processes, Said S. E. H. Elnashaie, Parag Garhyan, Marcel Dekker Publishers, 2003.
5. Process Modelling and Model Analysis, K. M. Hangos and I. T. Cameron, Academic Press, 2001.
6. Chemical Engineering Dynamics, John Ingham, Irving J. Dunn, Elmar Heinzle, J. E. Prenosil, Jonathan B. Snape, Wiley, 2007.

**Online Resources:**

1. https://nptel.ac.in/courses/103/107/103107096/

| **Course Code:** | **ANALYTICAL TECHNIQUES** | **Credits** |
|---|---|---|
| **CH 40006** | | **3-0-0: 3** |

**Pre-Requisites:** None

**Objective:** The objective of the course is to provide technical prospectus and overview of different analytical techniques for spectroscopic, spectrometric,microscopic, thermal and chromatographic characterization of materials

**Course outcome:** By the end of the course, the students will be able to,

1. Understand the basics and application of different analytical techniques and instrumentation used in different analytical laboratories for material characterization.
2. Categorically interpret the fundamental properties of the material using spectroscopic, spectrometric,microscopic, thermal and chromatographic characterization instruments

**Syllabus:**

**Spectroscopy:** Introduction, Spectroscopy methods: Infrared, UV-Visible, Fluorescence, Nuclear Magnetic Resonance, Atomic Absorption.

**Spectrometry:** Mass, Matrix-assisted laser desorption/ionization (MALDI)

**Microscopy:** Introduction, Atomic Force Microscopy, Field Emission Scanning Electron Microscope with EDXS (Energy-dispersive X-ray spectroscopy), Transmission Electron Microscopy, Laser Scanning Confocal Microscopy, Confocal Raman.

**Thermal analysis:** Differential Scanning Calorimetry, Thermal Gravimetric Analysis

**Chromatography:** Introduction, Thin-Layer Chromatography, Types of Column Chromatography: Affinity and Ion Exchange, Gel Permeation and HPLC, Gas Chromatography–Mass Spectrometry

**Text / Reference Books:**

1. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press; 8th Edition,Cambridge University Press, (2018)

2. D. A. Skoog and D. M. West, Fundamentals of analytical chemistry, Cengage Publishers; 9th Edition. Cengage Publishers, (2014)

3. G. D. Christian, P. K. Dasgupta and K. A. Schug, Analytical Chemistry, Wiley Publishers; 7th Edition , Wiley, (2013)

4. R. M. Silverstein, F. X. Webster, D. J. Kiemle and D. L. Bryce, Spectrometric Identification of Organic Compounds, Wiley Publishers; 8th Edition, Wiley, (2014)

5. D. B. Williams and C. B. Carter, Transmission electron microscopy-a text book for material science, Springer Publishers; 2nd Edition ,Springer, (2009)

6. Introduction to Polymer Science. Charles E. Carreher. Jr.,4th Edition,CRC Press, (2017)

| **Course Code:** | **PETROLEUM REFINERY ENGINEERING** | **Credits** |
|---|---|---|
| **PE 40003** | | **3-0-0: 3** |

**Objective:** The objective of the course is to provide technical prospectus and overview of different processes and unit operations in petroleum refineries to the students.

**Course outcome:**

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

1. Characterize the crude based on the assay data and interpret different parameters associated with the crude characterization and petroleum products to different unit operations in the refinery
2. Obtain technical information and overview of various unit operations in petroleum refinery with respective feed, products and process parameters of each unit operation in the refinery

**Syllabus:**

**Introduction**: Introduction to petroleum refinery and brief overview of different refinery operations. Brief Description of Petroleum refinery in Indian Context.

**Characterization of crude oil and refinery products** Origin of petroleum crude oil, TBP and other distillation tests, Petroleum products-their properties, specifications and testing – different properties like flash point, fire point, smoke point, aniline point, carbon residue, kinematic viscosity, pour point, freezing point etc. Interpreting crude Assay data

**Petroleum refinery distillation**: Pre-fractionation and atmospheric distillation of crude. Stabilization of naphtha. Vacuum distillation of RCO.

**Reforming of Naphtha:** Isomerization, Alkalization and Polymerization

**Residue Upgradation processes**: Delayed coking process, Vis-breaking, FCC unit.Furfural/Phenol/NMP extraction, Solvent dewaxing, propane deasphalting. Production of lube oil base stock

**Hydrotreatment processes in refining**: Hydro-Desulfurisation, Hydrofinishing, Hydrocraking, Residual Hydrocracking and Hydrogen Generation unit (HGU)

**Refinery equipment and Elements of design of refinery units:** furnaces, distillation columns, reactors, pumps, compressors and piping.

**Environmental impact of refineries**

**References/Text books**

**Text Books:**

1. Petroleum Refinery Engineering by W. L. Nelson,4th Edition, McGraw-Hill, (1958)

2. Petroleum Refining, Technology & Economics by J. H. Gray & G. E. Handwerk,5th Edition, CRC Press, (2007)

3. Petroleum Refinery Distillation by R. N. Watkins,2nd Edition, Gulf publishing company,(1979)

4. Modern Petroleum Refining Processes by B. K. B. Rao, 6th Edition, CBS Publishers,(2014)

5. Fundamentals of Petroleum and PetroChemical Engineering by Uttam Ray Chaudhuri, CRC Press,1st Edition,(2011)

**Reference Book:**

1. The Chemistry & Technology of Petroleum by J. G. Speight, CRC Press, 5th Edition, 2014

| **Course Code:** | **AIR POLLUTION CONTROL** | **Credits** |
|---|---|---|
| **CH 40009** | | **3-0-0: 3** |

**Pre-Requisites:** Basics science

**Objective**: To provide the scientific and technical background of air pollution, its monitoring techniques, transport and dispersion modeling, and air pollution control technologies.

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

1. Identify the major sources of air pollution and understand their effects on health and environment.
2. Evaluate the dispersion of air pollutants in the atmosphere and to develop air quality models.
3. Learn the fundamental aspects of sampling techniques for atmospheric and stack pollutants.
4. Choose and design control techniques for particulate and gaseous emissions.

**Syllabus:**

**Introduction:** Introduction to principal aspects of air pollution; History of air pollution; Sources of air pollution; Effects of major air pollutants; Current policies, standards and objectives; Air pollution legislation.

**Meteorology and air quality modeling**: Meteorology as applied to air pollution and dispersion of air pollutants; Atmospheric chemistry, Aerosol behavior; Transport and dispersion modeling. Commercial air quality models (ADMS and USEPA).

**Monitoring and control techniques:** Monitoring of emissions and air pollutants in ambient air; Engineering control of stationary sources; Modeling and control of emission from road transport and from industrial sources. Selection of control equipments; Process change, fuel change; pollutant removal and disposal of pollutants; Control devices and systems, removal of dry particulate matter, liquid droplets and mist removal, gaseous pollutants and odor removal.

**Indoor air pollution:** Indoor air pollution; Personal exposure to air pollution.

**Economics in air pollution control**: Economics and trends in air pollution control.

**Text Books**

1. H.S. Peavy, D. R. Rowe, G. Tchobanoglous, Environmental Engineering, Mcgraw-Hill (1985).
2. M.N. Rao, H.V.N. Rao, Air Pollution. McGraw Hill, Indian Edition (2017).

**Reference**

Richard C. Flagan, John H. Seinfeld, Fundamentals of Air Pollution Engineering. Prentice Hall (1988).

# Proposed Fee Structure – M.Tech

| S.No. | Item of Fee and Deposits | Value in Rs. |
|---|---|---|
| I. INSTITUTE FEE (A,B,C) | | |
| A. One Time Fees (during admission) | | |
| A1 | Admission fee | 250 |
| A2 | Grade card fee | 250 |
| A3 | Provisional certificate fee | 250 |
| A4 | Alumni Life Membership Fee | 2000 |
| A5 | Publication Fee | 500 |
| A6 | Training and Placement Fee | 1250 |
| | **Total A** | **4,500** |
| B. Semester Fees (Institute Fee) | | |
| **B1** | **Tuition Fee#** | **10000** |
| B2 | Examination Fee | 1000 |
| B3 | Registration – Enrolment Fee | 1000 |
| B4 | Water and Electricity Fee | 1000 |
| B5 | Internet Fee | 1500 |
| B6 | Student Amenities | 1500 |
| | **Total B** | **16,000** |
| C. One Time Deposits (refundable) | | |
| C1 | Institute Deposit | 1500 |
| C2 | Library Deposit | 2000 |
| C3 | Hostel Deposit | 4000 |
| | **Total C** | **7,500** |
| | | |
| | **Grand Total (A+B+C)** | **28,000** |
| | | |
| | | |

# SC/ST/PwD students are exempted from payment of tuition fee. Under self-sponsered category, the tuition fee is Rs. 20,000.

Note: Charges are based on rates during the respective semester. A nominal change in charges may be applicable.


# Indian Institute of Petroleum and Energy
# Visakhapatnam

## M. Tech. Programme
## in
## Chemical Engineering

**Overview:**

Indian Institute of Petroleum and Energy (IIPE), Visakhapatnam is an "Institute of National Importance" established under the Act of Parliament. It aims to provide highly skilled manpower for the relevant sector through strong fundamental technical education and carry out collaborative research to develop the technologies that will bridge the gaps towards sustainable growth. To achieve this, a two year M.Tech program in Chemical Engineering is started from the 2022-2023 academic year.

**Eligibility for M. Tech programme in Chemical Engineering:**

The eligibility criteria for admission into M.Tech. programme is similar to that adopted by the "Indian Institutes of Technology" (IITs) and other premier institutions in India.

| Discipline | Eligibility |
|---|---|
| Chemical Engineering | B.Tech. or an equivalent degree in Chemical Engg./Chemical Technology/Bio-Chemical Engg./Bio-Technology/Energy Engg./Petrochemical Engg./Electrochemical Engg. with a first class or minimum 60% marks or 6.0 CGPA (55% marks or 5.5 CGPA for SC/ST students) in the qualifying exam. In addition, the applicant must also have a valid **GATE score**. |

**Intake in each academic year**: 20

Out of the 20 seats, 10 seats will be admitted through GATE score/rank and the remaining 10 seats will be admitted through self sponsored mode. Reservations will be followed as per Govt. of India norms.

**Requirements for admission through Self sponsored category**: The candidates need to qualify a written test/interview as specified by the department. GATE score is not mandatory.

**Stipend**: A monthly stipend of Rs. 12,400/- is available to the selected candidates admitted through GATE score. No stipend will be provided for the students admitted under the self sponsored category.

**Start date:** 2022-23 Autumn semester

**Academic requirement:**

The following Table lists the minimum residence, maximum duration, and credit requirements for obtaining M.Tech. degree.

| Total Credits required for Graduation | Credits to be earned through Course Work | Credits to be earned through summer internship | Credits to be earned through Thesis Work | Minimum Residence (Semesters) | Maximum Duration (years) |
|---|---|---|---|---|---|
| 72 | 40 | 6 | 26 | 4 | 4 |

*List of Subjects for M.Tech in Chemical Engineering*

## ***Semester I***

| S. No. | Course Code | Course Title | Components | | | |
|---|---|---|---|---|---|---|
| | | | **L** | **T** | **P** | **C** |
| 1 | CH51001 | Mathematical Methods in Chemical Engineering | 3 | 0 | 0 | 3 |
| 2 | CH51002 | Advanced Transport Phenomena | 3 | 0 | 0 | 3 |
| 3 | CH51003 | Process Control and Automation | 3 | 0 | 0 | 3 |
| 4 | | Elective I | 3 | 0 | 0 | 3 |
| 5 | | Elective II | 3 | 0 | 0 | 3 |
| 6 | | Elective III | 3 | 0 | 0 | 3 |
| 7 | CH51005 | Chemical Engineering Lab | 0 | 0 | 3 | 2 |
| 8 | CH51006 | Seminar | 0 | 0 | 2 | 1 |
| **Total** | | | **18** | **0** | **5** | **21** |

## Electives - I, II & III

| Course code | Course Title |
|---|---|
| CH51020 | Multiphase Flow |
| CH51021 | Process Optimization |
| CH40004* | Advanced Separations |
| CH40010* | Solar Energy, Photovoltaic Energy |
| CH51022 | Waste to Energy Conversion |
| CH51023 | Interfacial Science |
| CH51024 | Surface Engineering |
| CH51025 | Process Intensification |

* Common to B.Tech and M.Tech students as Elective course

## ***Semester II***

| S. No. | Course Code | Course Title | Components | | | |
|---|---|---|---|---|---|---|
| | | | **L** | **T** | **P** | **C** |
| 1 | CH52001 | Chemical Reactor Design | 3 | 0 | 0 | 3 |
| 2 | CH52002 | Advanced Chemical Engineering Thermodynamics | 3 | 0 | 0 | 3 |
| 3 | CH52003 | Machine Learning in Process Engineering | 3 | 0 | 0 | 3 |
| 4 | | Elective IV | 3 | 0 | 0 | 3 |
| 5 | | Elective V | 3 | 0 | 0 | 3 |
| 6 | CH52004 | Process Simulation Lab | 0 | 0 | 3 | 2 |
| 7 | CH52005 | Comprehensive Viva | 0 | 0 | 0 | 2 |
| **Total** | | | **15** | **0** | **3** | **19** |

## Electives - IV & V

| Course code | Course Title |
|---|---|
| CH52020 | Energy Storage and Conversion Devices |
| CH52021 | Heterogeneous Catalysis Science and Technology |
| CH52022 | Computational Fluid Dynamics |
| PE30014* | Bio Energy |
| CH30010* | Wastewater Management |
| CH40013* | Process Modeling and Simulation |
| CH40006* | Analytical Techniques |
| CH40003* | Petroleum Refinery Engineering |
| CH40009* | Air Pollution Control |

* Common to B.Tech and M.Tech students as Elective course

# Second Year

## Semester-III

| S. No. | Course Code | Course Title | Components | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| 1 | CH53001 | Summer Internship ** | 0 | 0 | 0 | 6 |
| 2 | CH53002 | Thesis Part-A | 0 | 0 | 30 | 12 |
| **Total** | | | **0** | **0** | **30** | **18** |

**** Summer internship needs to be carried out for 3 months at the end of the second semester. The evaluation of the summer internship will be carried out in the beginning of the third semester.**

## Semester-IV

| S. No. | Course Code | Course Title | Components | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| 1 | CH54001 | Thesis Part-B | 0 | 0 | 30 | 14 |
| **Total** | | | **0** | **0** | **30** | **14** |

**Certification Course**

**On**

# Petroleum and Natural Gas: Upstream and Downstream Operations

**(15-18 JUNE, 2022)**

**Organized by**

**Indian Institute of Petroleum & Energy (IIPE)**

**Visakhapatnam – 530 003**

**Andhra Pradesh, INDIA**

## Introduction

The training program is aimed at providing refreshing the basics of both upstream and downstream processing methods in petroleum and natural gas production. The Training program will be conducted by experienced people working in the area of upstream and downstream process technologies and related domains. In addition to faculty of Petroleum and Chemical Engineering Departments at IIPE, experts from other academic and research institutes also will deliver the lectures. The program is divided into two segments consisting of upstream processes and downstream processes. While refreshing the basics, advanced concepts will be taught on the topics given below. It is tentatively planned to teach all the modules for a duration of 40 hours.

## Tentative Topics of the Program

| **Module: Upstream Operations** | |
|---|---|
| | Fundamentals of Petroleum Geology |
| | Geomechanics & Wellbore Stability |
| | Petroleum Exploration & Formation Evaluation |
| | Overview of Drilling Technology for HC wells |
| | Basics of Reservoir Engineering |
| | Overview of Petroleum Production Operations |
| | EOR and Production Enhancement Policies |
| | Field Development Plans and Policies |
| | Offshore Operations |
| | CSR policies in oil and gas sector |
| | Petroleum Economics |
| | Overview of Petroleum Industries and Future Perspective |
| | Overview of gas processing methods |
| **Module: Downstream Operations** | |
| | Introduction to down-stream processing and crude characterization |
| | Distillation |
| | Overview of Mass transfer operations |
| | Solvent extraction, Propane deasphalting |
| | Hydrotreating, Hydrocracking, Catalytic cracking |
| | Catalytic reforming, Alkylation, Polymerization, Isomerization |
| | Visbreaking, Delayed coking, Flexicoking, Catalytic dewaxing |
| | Solvent dewaxing, Blending |
| | Sulphur Recovery Unit |
| | Types of hydrogen, methods of production of hydrogen, storage, safety |

## About the Institute

The Indian Institute of Petroleum and Energy (IIPE) is an autonomous institute under the Ministry of Petroleum & Natural Gas, Govt. of India and backed by public sector Oil and Gas giant viz. HPCL, IOCL, ONGC, GAIL, OIL whose CEOs are on the Board of IIPE. The objective of establishing IIPE is to meet the quantitative and qualitative gap and supply of skilled manpower for Petroleum Sector and to boost the research activities needed for growth of sector. Learn, Experience and Implement is what IIPE strives for and inculcate the same in the students. It has started its operations in Visakhapatnam, the state of Andhra Pradesh at AU College of Engineering as its temporary campus. IIPE is offering two undergraduate courses viz. Petroleum Engineering and Chemical Engineering and PhD programs in all disciplines. The campus is fully loaded with laboratories, workshops, e-library and Wi-Fi access for all the students. Within a span of short time, IIPE entered into academic MoUs with Texas A & M University, USA and University of Houston, USA for research collaboration, faculty exchange, student internships etc.

## Eligibility to attend the training program

This course is specifically designed and offered to the engineers from public sector units such as HPCL, IOCL, BPCL, OIL, etc..

## Registration fee

The Registration fee for attending the course is Rs. 25,000/-.

## How to apply

Applications in the prescribed format (given below) should be sent by email to the following email so as to reach on or before **29th May 2022.** The number of participants is limited to 30.

**Address:** **Coordinator, CC-PNGUDO**
**IIPE, Visakhapatnam – 530 003, Andhra Pradesh**
**E-mail:**
**Phone No.:**

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# Application Form

## Certification Course on
## Petroleum and Natural Gas: Upstream and Downstream Operations
## (15-18 JUNE, 2022)

## Organized by IIPE, Visakhapatnam

1. Full Name:
2. Gender:
3. Educational Qualification:
4. Current Position:
5. Department:
6. Organization:
7. Address for correspondence:

8. E-mail: Phone No.:

9. Any other details:

Place:

Date:

Signature of the applicant

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**Certification Course**

**On**

# Petroleum and Natural Gas: Upstream and Downstream Operations

**(15-18 MAY, 2022)**

**Organized by**

**Indian Institute of Petroleum & Energy (IIPE)**

**Visakhapatnam – 530 003**

**Andhra Pradesh, INDIA**

## Introduction

The training program is aimed at providing refreshing the basics of both upstream and downstream processing methods in petroleum and natural gas production. The Training program will be conducted by experienced people working in the area of upstream and downstream process technologies and related domains. In addition to faculty of Petroleum and Chemical Engineering Departments at IIPE, experts from other academic and research institutes also will deliver the lectures. The program is divided into two segments consisting of upstream processes and downstream processes as given below. It is tentatively planned to teach all the modules for a duration of 40 hours.

## Tentative Topics of the Program

| **Module: Upstream Operations** | |
|---|---|
| | Fundamentals of Petroleum Geology |
| | Geomechanics & Wellbore Stability |
| | Petroleum Exploration & Formation Evaluation |
| | Overview of Drilling Technology for HC wells |
| | Basics of Reservoir Engineering |
| | Overview of Petroleum Production Operations |
| | EOR and Production Enhancement Policies |
| | Field Development Plans and Policies |
| | Offshore Operations |
| | CSR policies in oil and gas sector |
| | Petroleum Economics |
| | Overview of Petroleum Industries and Future Perspective |
| | Overview of gas processing methods |
| **Module: Downstream Operations** | |
| | Introduction to down-stream processing and crude characterization |
| | Distillation |
| | Overview of Mass transfer operations |
| | Solvent extraction, Propane deasphalting |
| | Hydrotreating, Hydrocracking, Catalytic cracking |
| | Catalytic reforming, Alkylation, Polymerization, Isomerization |
| | Visbreaking, Delayed coking, Flexicoking, Catalytic dewaxing |
| | Solvent dewaxing, Blending |
| | Sulphur Recovery Unit |
| | Types of hydrogen, methods of production of hydrogen, storage, safety |

## About the Institute

The Indian Institute of Petroleum and Energy (IIPE) is an autonomous institute under the Ministry of Petroleum & Natural Gas, Govt. of India and backed by public sector Oil and Gas giant viz. HPCL, IOCL, ONGC, GAIL, OIL whose CEOs are on the Board of IIPE. The objective of establishing IIPE is to meet the quantitative and qualitative gap and supply of skilled manpower for Petroleum Sector and to boost the research activities needed for growth of sector. Learn, Experience and Implement is what IIPE strives for and inculcate the same in the students. It has started its operations in Visakhapatnam, the state of Andhra Pradesh at AU College of Engineering as its temporary campus. IIPE is offering two undergraduate courses viz. Petroleum Engineering and Chemical Engineering and PhD programs in all disciplines. The campus is fully loaded with laboratories, workshops, e-library and Wi-Fi access for all the students. Within a span of short time, IIPE entered into academic MoUs with Texas A & M University, USA and University of Houston, USA for research collaboration, faculty exchange, student internships etc.

## Eligibility to attend the training program

This course is specifically designed and offered to the officers from ministry of petroleum and natural gas.

## Registration fee

The Registration fee for attending the course is Rs. 15,000/-.

## How to apply

Applications in the prescribed format (given below) should be sent by email to the following email so as to reach on or before **29th April 2022.** The number of participants is limited to 30.

**Address:** **Coordinator, CC-PNGUDO**
**IIPE, Visakhapatnam – 530 003, Andhra Pradesh**
**E-mail:**
**Phone No.:**

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# Application Form

## Certification Course on
## Petroleum and Natural Gas: Upstream and Downstream Operations
## (15-18 MAY, 2022)

## Organized by IIPE, Visakhapatnam

1. Full Name:
2. Gender:
3. Educational Qualification:
4. Current Position:
5. Department:
6. Organization:
7. Address for correspondence:

8. E-mail: Phone No.:

9. Any other details:

Place:

Date:

Signature of the applicant

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## 2 Year M.Sc. courses leading to the award of M.Sc. Degrees

**Courses:** 2 Year M.Sc. program

**Program Duration**: The normal duration of programs leading to the degrees to be awarded under these Regulations are **2 Years** for M.Sc. Program

**Maximum Time Limit:** The total time to earn the degree (inclusive of the period of Withdrawal, if any) is limited to **4-years for the 2 Year M.Sc.** of the 2 Year M.Sc. Program.

# Academic Calendar

The academic session is divided into two semesters each of approximately 15 weeks' duration: An **Autumn Semester** (July-November) and a **Spring Semester** (January-April).

The Senate-approved schedule of academic activities for a session, inclusive of dates for registration, mid-semester and end-semester examinations, inter-semester breaks etc., shall be laid down in the Academic Calendar for the session and published on Institute Website.

# Admission

Admission to 2 Year M.Sc. Programs will be made in the Autumn Semester of each session, at the First-Year level, through a Joint Admission Test (**JAM**) conducted by one of the IITs every year by rotation under the supervision of a Joint Admission Committee, which comprises of representatives from all the IITs.

All students admitted to any of the courses including those accepted under above shall be required to pay at the time of joining and also in subsequent semesters prevalent tuition and other fees as prescribed by the Institute till they are on roll.

The Institute reserves the right to cancel the admission of any student, and ask him/her to discontinue his/her studies at any stage of his/her career on grounds of unsatisfactory academic performance, irregular attendance in classes, or indiscipline.

# Attendance

Attendance in all classes (lectures, tutorials, laboratories, workshops, Extra Academic Activity including its related camps and other publicized activities etc.) is compulsory. A student may be **debarred** from appearing at an examination on the ground of unsatisfactory attendance.

The teacher concerned may condone absence from classes for a very short period due to unavoidable reasons provided he/she is satisfied with the explanation.

If the period of absence is for a **short duration** (of not more than two weeks) application for leave shall have to be submitted to the Head of the Department concerned stating fully the

reasons for the leave requested for along with supporting document(s). The Head of the Department will grant such leave.

Absence for a period not exceeding two weeks in a semester due to sickness or any other unavoidable reason for which prior application could not be made may be condoned by the Head of the Department provided he is satisfied with the explanation.

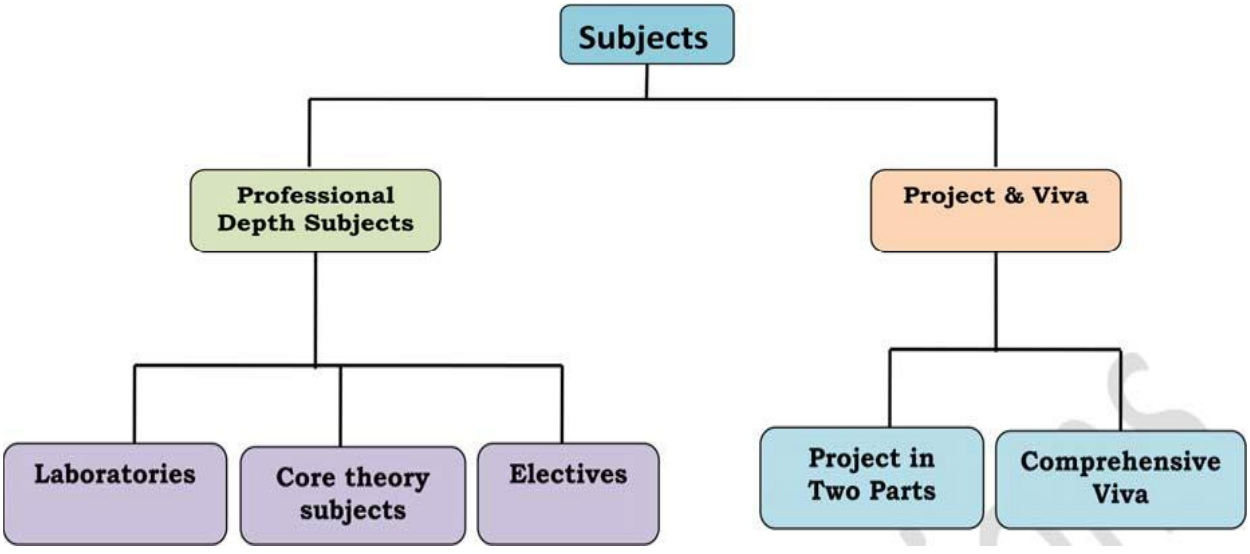
If the period of absence is likely to **exceed two weeks**, a prior application for grant of leave will have to be submitted through the Head of the Department to the Dean (academic affairs), with the supporting documents. The decision to grant or condone such leave shall be taken by the Dean (academic affairs) after considering the recommendation of the Head of the Department.

It will be the responsibility of the student to get his absence from classes condoned by the appropriate authority.

Absence from classes without prior permission will be considered as an act of indiscipline. A student must intimate his/her absence to the Warden of the Hall in which he/she is residing, before availing of any leave. Before proceeding on medical leave should be informed and before rejoining the institute, the student should obtain a fitness certificate.

Medical leave of a maximum period of one month during the semester is allowed. Beyond one month the rejoining will be considered on a case-to-case basis.

## Components of the 2 Year M.Sc. Program




## Semester Registration

From the second semester onwards only those students will be permitted to register who have:

Cleared all Institute and Hall dues of the previous semesters,
Paid all required prescribed fees for the current semester, and
Not been debarred from registering for a specified period on disciplinary or any other ground.

**Eligible Students will be presented with a broad time window, as specified in the Academic Calendar to Pay the Semester Registration Fee and finalize his/her subject Registration by suitable choice of Electives/Additional or Backlog subjects for each Semester.**

**It is mandatory for the student to be present in the Institute and report to their faculty advisors on or before the day from which the classes commence (as notified in the Academic Calendar).**

**Registration** by the student and approval of registration by Faculty Adviser should be **completed within the specified date** as per **Academic Calendar**.

**No late registration is allowed**. However, late registration is permitted only if a student has taken permission a prior or has medical reason/calamity in the family or any exceptional/ emergency circumstances.

## Guidelines for registration

A student who has cleared all curricular requirements up-to-the previous semester will register for all subjects of the current semester in accordance with the curriculum.

All backlog subjects of the corresponding semester have to be registered first.

Students having only one backlog subject in a semester may register for the prescribed credit of the semester in addition to the backlog subject.

For students having more than one backlog subject in a semester, the registered credit in the semester inclusive of backlog subjects must not exceed **28**.

For students repeating a year, the registered credit in a semester must not exceed **20** in consultation with the Head of the Department. However, on the recommendation of the Department and approval of the Dean (Academic Affairs), a student may be allowed to take maximum **23** credits. He/She may register for subjects of P grade as improvement along with backlog subjects, with total registered credit not exceeding the limit of **20/23 as the case may be**.

The credits of Industrial Training, field, comprehensive viva voce and EAA should be excluded while calculating the 28 or 16 credit limits per semester for backlog/year repeating students.

In registration for a subject, prerequisite must be taken care of. Students may be allowed to take Departmental elective subjects instead of professional breadth electives.

Registration in the subjects of same slots will not be allowed.

Subject to availability, a student, irrespective of his/her level or discipline of study may be allowed to take a subject including an M.Tech. subject as an Elective, Breadth or Additional Subject **Students who have a Backlog in a Breadth or an Elective may register in another Breadth or Elective. The Elective must be in the same group of Electives offered in the Semester concerned**.

Final year students may be allowed to take prescribed credit and, in addition, maximum two backlog subjects in a semester provided he has a CGPA of 6.00 and above so that he/she can clear all requirements of the degree if otherwise there is no time clash.

## Academically Weak Students:

Such students will be **divided into two categories based on their Notional CGPA** (calculated on the basis on **Total Credit Taken**)

**A.** A student having CGPA < 6.0
**B.** A student who has more than two backlogs/unregistered subjects (regardless of CGPA).

The faculty advisors will set up a meeting date every month and it will be mandatory on the part of the students to attend these meetings. During the meeting the problems of student will be discussed and measures to improve their Academic Performance suggested. A report of these meetings must be recorded for each student.

## Restriction limits on Registration for Academically Weak Students

Students will be ***divided into two categories based on their Notional CGPA*** (calculated on the basis on ***Total Credit Taken***)

- ***Category 1***: Students with **CGPA >=6.0**
- ***Category 2***: Students with **CGPA < 6.0**

Registration limits will depend on the students' category and the following limits will be imposed based on the ***number of subjects***:

**Category 1: No restriction on the number of subjects**. The student, however, must register for the Backlog/Unregistered subjects first. A student may register for a maximum of ***24*** **credits**. In case of **final year,** where the normal credit loading itself is around **24 credits due to the Project component**, a student may be allowed **two backlogs over and above the prescribed credit limit** of the semester.

**Category 2:** The registered credit in a semester must not exceed **21 in** consultation with Faculty Adviser and Head of the Department. However, on the recommendation of the Department and approval of the Dean (UGS), a student may be allowed to take maximum **23** credits. He/She may register for subjects of P grade along with backlog subjects, with total registered credit not exceeding the limit of **21/23 as the case may be**. The student must **register** for the

**Backlog/Unregistered** subjects **first**. Students, in this category, will be allowed to **register only for one Project at a time**. The credit limit is inclusive of improvement subjects.

Students who have cleared all the curricular requirements upto the previous semester and obtained CGPA lower than 6.00 may be allowed, on the recommendation of the Head of the Department and the approval of the Dean (Undergraduate Studies), to re-register in one or more subjects in which he/she received 'P' grade(s), so as to improve his/her CGPA to 6.00 or above, provided that the subject(s) is/are otherwise being offered in that semester and there is no clash in the time table. The grade will be revised and recorded only if there is an improvement.

A student who has been debarred from appearing at an examination either (i) as per recommendation of the subject teacher for unsatisfactory attendance or (ii) by the Institute as a measure of disciplinary action or (iii) for adopting malpractice at an examination, and consequently awarded a grade 'X', may reregister for the subject(s) after the term of the debarment expires, provided that other provisions of this regulations do not prevent him.

With the concurrence of the Faculty Adviser a student may be allowed to change his/her registration of subjects within one week from the day of registration.

If eligible a student may be allowed to register in additional subjects, with the concurrence of the Faculty Adviser, within one week from the day of registration.

# De-registration

The student can be de-registered in a subject of a semester by the concerned teacher on the ground of poor attendance.

If a student does not have a minimum of 80% attendance in a subject, he/she can be de-registered from the subject at the discretion of the subject teacher.

Only one-time de-registration is permissible and no revocation of the deregistered subject is admissible, expect on genuine medical grounds.

Email Warning should be given to the students by the subject teacher prior to de-registration.

The de-registration process shall commence after the Mid-semester Examination. However, in case of projects, comprehensive viva voce and Summer Training/Internship, there is no scope for de-registration by the concerned teachers.

The de-registration will stop two weeks before the commencement of the End Semester Examination.

# Grading System

As a measure of students' performance, a 7-scale grading system using the following letter grades and corresponding grade points per credit, as shown in Table will be followed:

| **Performance** | **Letter Grade** | **Grade point Per Credit** |
|---|---|---|
| Excellent | EX | 10 |
| Very good | A | 9 |
| Good | B | 8 |
| Fair | C | 7 |
| Average | D | 6 |
| Pass | P | 5 |
| Fail | F | 0 |

In addition, there shall be one grading symbol **X** used to indicate that the student is **Deregistered/Debarred** in that particular subject.

A **Semester Grade Point Average** (**SGPA**) will be computed for each semester.

The SGPA will be calculated as follows:

$$SGPA = \frac{\sum_{i=1}^{n} C_i g_i}{\sum_{i=1}^{n} C_i}$$

where '**n**' is the number of subjects **registered** for the semester, '$_i C$' is the number of Credits allotted to a particular subject, and '$_i g$' is the gradepoints carried by the letter corresponding to the grade awarded to the student for the subject. SGPA will be rounded off to the second place of decimal and recorded as such. The SGPA would indicate the performance of the student in the semester to which it refers.

Starting from the second semester at the end of each semester, a **Cumulative Grade Point Average** (CGPA) will be computed for every student as follows:

$$CGPA = \frac{\sum_{i=1}^{m} C_i g_i}{\sum_{i=1}^{m} C_i}$$

Where '**m**' is the total number of subjects the student has **registered and cleared** from the first semester onwards up to and including the semester **S**,'$_i C$' is the number of Credits allotted to a particular subject '$_i S$' and '$_i g$' is the grade-point carried by the letter corresponding to the grade awarded to the student for the subject '$_i S$'. CGPA will be rounded off to the second place of decimal and recorded as such. The CGPA would indicate the cumulative performance of the student from the first semester up to the end of the semester to which it refers. The CGPA, SGPA and the grades obtained in all the subjects in a semester will be communicated to every student at the end of every semester. For determining the *inter se* merit ranking of a group of students, only the rounded off values of the CGPAs will be used.

When a student gets the grade 'F' in any subject during a semester, the SGPA and the CGPA from that semester onwards will be tentatively calculated, taking only 'zero point' for each such 'F' grade. After the 'F' grade(s) has/have been substituted by better grades during a subsequent

semester, the SGPA and the CGPA of all the semesters, starting from the earliest semester in which the 'F' grade has been updated, will be recomputed and recorded to take this change of grade into account.

**Conversion of CGPA into percentage Marks**: In case of a specific query by students/employers regarding conversion of CGPA into percentage marks, the following formula will be adopted for **notional conversion of CGPA** into percentage marks. ***Formula : % Marks = CGPA*10***

## Assessment of Performance

There will be continuous assessment of a student's performance throughout the semester and grades will be awarded by the subject teacher/co-ordination committee formed for this purpose.

In general there shall be no rigid marks-to-grade linkage. Difficulty levels of the examinations, tests, assignments, viva-voce and other factors that contribute to the final marks are to be considered by the teacher/co-ordination committee of a subject while converting marks into letter grades.

(a) The grades ***F*** and ***EX*** are to be considered as bench mark grades.
(b) The range of cut-off marks below which a student would be assigned an 'F' grade is 30-35 for the theory component and 35-40 for the laboratory component, the exact cut-off marks is to be decided by the teacher/coordination committee.
(c) The exceptionally brilliant performance is to be assigned an 'EX' grade. Even the best student of any class needs to be good enough to be awarded the 'EX' grade.
(d)For subjects which have a laboratory component (P-component) along with the theory, to secure any grade higher than 'F' a student has to achieve individually more than the cut-off marks in both the theory component and the laboratory component. Separate marks, each out of 100 (hundred), in the theory component (L- & T- components) and the laboratory component are to be ascertained first. A composite mark for the subject out of 100 is then to be computed by taking appropriate contribution of theory component and the laboratory component as shown in **Table**

| L-T-P | Credit | Theory (L-T component) | Laboratory (P-component) |
|---|---|---|---|
| 4-0-6 | 8 | 50 | 50 |
| 3-0-6 | 7 | 40 | 60 |
| 4-0-3 | 6 | 70 | 30 |
| 3-1-3 | 6 | 70 | 30 |
| 1-0-8 | 6 | 20 | 80 |
| 3-1-2 | 5 | 80 | 20 |
| 3-0-3 | 5 | 60 | 40 |
| 3-0-2 | 4 | 75 | 25 |
| 2-0-3 | 4 | 50 | 50 |
| 1-0-5 | 4 | 25 | 75 |
| 2-0-2 | 3 | 70 | 30 |
| 1-0-3 | 3 | 30 | 70 |
| 1-0-2 | 2 | 50 | 50 |

Once the numeric mark is obtained, the same is to be converted to letter grade following the guidelines given in **Table**

| Marks Range (m) | Grade |
|---|---|
| m >= 90 | EX |
| 80 <= m < 90 | A |
| 70 <= m < 80 | B |
| 60 <= m < 70 | C |
| 50 <= m < 60 | D |
| 40 <= m < 50 | P |
| m < 40 | F |

**Large Class Assessment:** In the case of a relatively large class and/or classes where the performance level depicts more or less a normal distribution:

(a) The average performance (around mean value of marks) is to be assigned 'C' grade. However, if by teacher's/co-ordination committee's perception the general level of the class is considered to be appreciably high, the average performance may be assigned 'B' grade.
(b) All other marks to grade conversion are to be done relatively with respect to the average performance in between (but excluding) the F and EX grades, which have already been assigned, by choosing appropriate boundary marks between grades.
(c) Normally, in a reasonably large class of students distribution of grades is expected to be as follows:

| Grade | Distribution |
|---|---|
| EX | <= 10% |
| A | 10 – 20 % |
| B, C, D | 20 – 35 % |
| P | 10 – 25 % |
| F | < = 5 % |

In the case where a student appears in the supplementary examination or attends summer quarter, the conversion from marks to grade would be done applying the same norm as was framed for the original class.

For classes where excessive bunching occurs resulting in almost all the marks tending to cluster into same category, conversion from marks to grade may be done using the Table 23.2, where 'm' stands for the marks obtained. However, the teacher may, on his/her perception of the difficulty level of assessment process undertaken, alter the boundary (cut-off) marks by +/- 5 marks.

For subject in which the theory component is greater than 1 (one), the subcomponents and the respective weights assigned to these are given below **Table**

| Subcomponent | Weight |
|---|---|
| Teacher's Assessment | 20% |

| | |
|---|---|
| Mid-Semester Examination | 30% |
| End-Semester Examination | 50% |

For assigning marks in Teacher's Assessment (T.A.) performance in home assignments, class-tests, tutorials, viva-voce, attendance etc., are to be considered. At least two class tests are to be conducted for a subject. The weights of different sub-components of T.A. are to be announced by the teacher at the beginning of the Semester.

For subjects in which the theory component is 1 (one), there would be no Mid-Semester or End-Semester Examinations. The marks of the theory component would be decided by performance in class-tests, home assignments, tutorials (if any), viva-voce, attendance etc. At least two class tests are to be conducted for the theory component of such a subject. The weights of different subcomponents are to be announced by the teacher at the beginning of the Semester.

For assigning marks in the laboratory component (P-component) the relevant sub-components that are to be considered are day-to-day work, regularity, tests (at least two must be conducted), assignments, viva-voce etc. Percentage weights of the different sub-components in deciding the final marks are to be announced at the beginning of the Semester.

The eight-week industrial training undergone by the students in the summer vacation after the sixth semester would be assessed within five weeks after the commencement of the seventh semester. The students are required to submit a written report on the training received and give a seminar, on the basis of which a grade would be awarded. The students are also required to submit to the Head of the Department a completion certificate in the prescribed form from the competent authority of the organization where the training was received, without which he/she would not be assessed.

The minimum total credit requirements that has to be satisfactorily completed for the award of a degree is depicted below:

| **Degree Type** | **Minimum Credits** |
|---|---|
| 2 Year M.Sc. program | 90 |

## Assessment of Project Work

Performance in the various activities involved in the project would be assessed individually at the end of each semester in which it is being carried out as per the curriculum. The student is required to submit a written report at the end of the semester. The Head of the Department would appoint a project evaluation board for the purpose of assessment.
The different components of evaluation and the weights assigned to these components are depicted below:

| Subcomponent | Weight |
|---|---|
| Supervisor's assessment | 40% |
| Project Report/Thesis (to be assessed by the board) | 20% |
| Evaluation Board's assessment | 40% |

The student is required to give a seminar on the project work done. The evaluation board would conduct the viva-voce. Dates for conducting the seminar and the viva-voce, to be held within ten days after the end-semester examination, would be announced in the academic calendar.

## Graduation Requirement

Complete all the credit requirements for the degree as laid down in the prescribed curriculum of the discipline.

Obtain a CGPA of 6.00 or higher at the end of the semester in which he/she completes all the requirements for the degree.

Have cleared all dues to the Institute, the Hall of Residence, the Library and the Department.

# RULES, REGULATIONS AND PROCEDURES RELATING TO POSTGRADUATE PROGRAMME LEADING TO THE DEGREE OF MASTER OF TECHNOLOGY

## 1. Introduction

Provisions of these regulations shall come into force with immediate effect and shall be applicable to all Postgraduate courses leading to the degrees of Master of Technology (M.Tech.)

## 2. Duration and Academic Calendar

2.1 The postgraduate programs shall be of a duration of 24 months spread over four semesters mentioned below, and the schedule of events in the semesters, i.e., the date of commencement, mid-semester and end-semester examinations etc., shall be laid down by the Senate every year in the Academic calendar:

| | |
|---|---|
| First (Autumn) Semester | - July to December |
| Second (Spring) Semester | - January to May |
| Third Semester | - June to December |
| Fourth Semester | - January to June |

2.2 A student admitted to the program will be required to successfully complete the four semesters at a stretch. However, sponsored students and regular students may be given permission to complete the program as per provisions given in para 9.6 under special circumstances.

## 3. Admission

### 3.1 Students with Assistantship

Admission to the Postgraduate program will be granted in the Autumn Semester of each year on the basis of the performance at

(i) A common all-India competitive test known as Graduate Aptitude Test in Engineering (GATE) in the cases of M.Tech.

(ii) The admissions will be made in order of merit based on a valid GATE score. The GATE score can be used for one time admission only.

(iii) Students from IITs/RGIPT/IIPE with a minimum CGPA of 8.0 will be admitted directly with assistantship in their respective disciplines.

### 3.2 Self-financing Students

Few seats will be filled under self financing, observing the same guidelines of admission as applicable for students with assistantship. GATE score is not mandatory. The admission will be based on a written test/interview as specified by the respective department.

3.3 **Sponsored Students**

Candidates who are employed in recognized organizations shall be eligible for admission as sponsored candidates to any of the postgraduate courses. The conditions and requirements for admission as a sponsored candidate are laid down separately in **Appendix-I**.

3.4 **Foreign nationals**

Eligible foreign nationals who have either

(i) been selected for award of Government assistantship/fellowship, or

(ii) been permitted by the Government of India to undergo studies as self-financing foreign student may also be admitted to any of the courses subject to acceptance of the academic standard of the applicants by the Institute. However,

(iii) those foreign nationals/non-resident Indians who passed the qualifying degree examination (B.Tech. or an equivalent degree, as the case may be) from an Indian University/Institute and are desirous of admission to any of the courses either with Government of India assistantship/fellowship or as a self- financing foreign student shall be required to qualify in GATE.

3.5 **Permanent staff members of the Institute**

Permanent non-teaching staff members of the Institute shall be eligible for admission to the M. Tech. programs subject to (i) prior permission obtained from the appropriate authority and (ii) fulfillment of the minimum prescribed qualifications and experience. They will however have to appear for an interview before the Departmental Academic Committee, DAC (PG & R) of the Department. The conditions governing such permission are given in **Appendix- II**. The composition of the DAC (PG&R) includes all the professors, associate professors, 4 assistant professors nominated by the HoD.

3.6 The Institute reserves the right to cancel the admission of any student and ask him/her to discontinue the studies at any stage of the program either due to unsatisfactory academic performance or unsatisfactory attendance in classes or indecent behavior or any other reason, as the case may be.

3.7 **Submission of result of qualifying examination**

Students shall have to submit a mark-sheet/ grade-card or provisional certificate as evidence for having passed the qualifying examination latest by the time of registration for the second semester, failing which their admission will be deemed to have been canceled.

3.8 The admission of any student will be treated as canceled and void, if at any stage it is detected that he/she has obtained admission based on false information or had by malafide submitted fake mark sheet/degree, caste/PH certificate, etc., or suppressed

some material information of academic nature or otherwise required for his/her admission in the Institute.

3.9 The Senate may either appoint a Committee to examine any specific case or review rules regarding admission time-to-time.

## 4. Residence

4.1 The Institute is fully residential and all students are required to reside in and be a member of the Halls of Residence to which they are assigned at the time of admission.

4.2 Detailed rules regarding residential requirements are given in **Appendix-III**.

## 5. Attendance

5.1 Attendance in all classes of the subjects registered for (Lectures, Laboratories/Practicals, Workshop, Design, Seminar etc.) is compulsory. If the attendance of any student in any subject(s) is considered to be unsatisfactory, the student's registration in the concerned subject(s) shall be canceled and the student may be asked to discontinue.

5.2 A student shall be entitled to the following types of leave during the academic year counted from the date of commencement of the session concerned as prescribed in the Academic Calendar of the Institute

| Nature of Leave | Maximum number of Days | Sanctioning Authority |
|---|---|---|
| Casual leave | 12 | Head of the Department |
| Medical leave* | 10 | Head of the Department |

* (Provided that the application is supported by a certificate from the Institute Hospital).

**N.B.** (i) Leave not availed of by a student in the first year shall not accumulate. The concerned Department will maintain the leave record.

(ii) If a student is absent without permission for more than one month his/her name will be removed from the rolls.

(iii) A student is not entitled to any vacation on account of inter-semester break, summer and winter vacations.

5.3 Any absence over and above the prescribed limit of admissible leave shall entail deduction from the assistantship, besides other action as may be decided by the Institute.

## 6. Conduct and Discipline

6.1 Students shall conduct themselves within and outside the precincts of the Institute in a manner befitting the students of an institution of national importance.

6.2 Detailed rules regarding conduct and discipline are given in **Appendix-IV**.

## 7. Course Structure

7.1 Weightage of the courses shall be reckoned in credits, as specified against each subject.

7.2 In order to qualify for M. Tech. degree of the Institute, a student is required to complete 72-80 credits as required by the prescribed curricula of the Department concerned.

7.3 The credits that have to be completed satisfactorily for the degree are distributed as follows:

| | **Number of credits :** |
|---|---|
| (a) Course work (including theory, seminar, laboratory) | 40 - 48 |
| (b) Summer Internship (between second and third semesters) | 06 |
| (c) Thesis/Project work (3rd and 4th semesters) | 26 |

A student is required to qualify separately in each of the components (a), (b) and (c) listed above.

7.4 The curriculum for a course shall comprise core and elective subjects. The list of elective subjects may include subjects from allied disciplines also. The curriculum will also include compulsory seminar to be delivered by all students. Departments will prescribe the seminar carrying 1 (one) credit in each of the First (Autumn) Semester and the Second (Spring) Semester.

## 8. Summer Internship, Comprehensive viva-voce and Thesis/Project Work

8.1 **Summer Internship:** Students shall carry out internship during the period available between second semester and third semester at IIPE/other research institutes/academic institutions/industry. The evaluation for the summer internship in the beginning of the third semester.

8.2 **Comprehensive viva-voce:** A comprehensive viva-voce will ordinarily be held immediately after the end of second semester examination. The oral examination will carry 2 (two) credits and cover the entire course of study during the first and the second semester. The viva voce will be conducted by a Board consisting of members from the faculty of the Department. The grade obtained in the viva- voce shall be used for computing the SGPA at the end of the 2nd semester.

The Head of the Department may invite a member of faculty from an allied Department to be associated with the conduct of the comprehensive viva-voce.

8.3 **Thesis/Project work:** A student will carry out project work during the third and fourth semester. The project carries a total of 26 credits (12 credits being assigned in third semester and 14 credits during fourth semester). A student shall carry out the project work under the supervision of a member of the teaching staff and/or a Scientific Officer of the Institute.

A student may undertake to execute the project in collaboration with an Industry, Research and Development Organization or another academic institution/University where sufficient facilities exist to carry out the project work. In addition to the Supervisor from the Department, a Joint Supervisor may be appointed from the Industry, a Research Laboratory or another University with the approval of the Departmental Academic Committee (PG & R). The Joint Supervisor will be associated with the guidance and may also be associated with evaluation of the performance of the student. The internal Supervisor may, if felt necessary, visit the Industry, or the Research Laboratory or the University in connection with the project of a student.

For purpose of assessment, the performance of a student in the project work may be divided into the following parts:

**Third Semester:** The student shall have to submit a report of the work done during the Semester and present a seminar lecture of 20-25 minutes duration (followed by a discussion) to the members of the Project Assessment Committee formed (inclusive of the co-supervisor) by the Department by 31st December.

The grades shall be assigned on the basis of marks awarded in the following manner on :

| | |
|---|---|
| Project work to be given by the Supervisor | 50% |
| Report and seminar lecture by Project Assessment Committee | 50% |

**Fourth Semester:** The student shall submit the dissertation latest by 30th April. The student will have to appear at a viva-voce and deliver a seminar lecture of 20-25 minutes duration. The dissertation seminar and viva-voce shall be conducted by the last date fixed as per the academic calendar by the Senate. The grades shall be assigned on the basis of marks awarded in the following manner:

| | |
|---|---|
| Project work<br>(marks to be awarded by the supervisor) | 50% |
| Dissertation<br>(marks to be awarded by the external examiner/member from allied department from IIPE) | 25% |
| Viva-voce<br>(marks to be awarded by the Project Assessment Committee) | 25% |

A student has to have a satisfactory performance in each component separately to qualify for the degree.

(a) **Project Work*:*** Assessment will involve the day-to-day work of the student for the project. The project supervisor(s) will periodically review the student's progress over the period and finally give an assessment of the work done by the student.

(b) **Dissertation and Viva-Voce*:*** A student shall be required to submit a dissertation on the Project Work carried out by him/her. Three/four bound copies of the thesis will be submitted to the Head of the Department by the last date prescribed in the Academic Calendar for the purpose. A brief bio-data and a one-page abstract of the project work carried out will be required to be appended to the dissertation.

Dissertation viva voce will be held by the date fixed in the Academic Calendar. In the cases of students who are required to do the project work over an extended period and submit dissertation at a later date, an expert from an allied Department within the Institute may be associated with the assessment of dissertation and conduct of viva- voce.

Extension of project work beyond the submission deadline in very special cases may be granted by the Dean on recommendation of the Department for a maximum period of 3 months. The viva voce will have to be completed within the

extension period. The student shall not be eligible either for award of assistantship during the extension period or any medal or prize. The student who have been absent on medical grounds and his/her project has been extended, he/she will also not be eligible for award of Medal or Prize.

8.4 **Projects in collaboration with industry**

A student may, with the approval of the Head of the Department, do the project work with an Industry, a Research and Development Organization or another academic Institution/University. The student shall acknowledge the involvement and/or contribution of an industry, R & D organization or University in completing the project in the dissertation and a certificate to this effect, issued by the supervisor from the industrial organization, will be appended to it.

It is mandatory for all students (specially those who do their project in an industry, R & D organization or University in India or abroad) to make a full disclosure of all data on which they wish to base their thesis. They cannot claim confidentiality simply as it would come into conflict with the Industry's, R & D laboratory's or other University's own interests. Any tangible intellectual property other than copyright of thesis may have to be assigned to the Institute; the copyright of the thesis itself would however lie with the student as per the IPR policy in force at the time. The student's thesis shall be rejected unless there is full and complete disclosure of data and the student will not be eligible for M.Tech. degree of the Institute in such cases.

9. **Registration**

9.1 All students of the M.Tech. courses are to register for the required credits at the commencement of each of the four semesters, on the day announced for such registration.

9.2 The Head of the Departments concerned shall organize the registration of the students.

9.3 A student who is unable to register on the date fixed for registration may be permitted, in consideration of any compelling reason, late Registration within the next three working days on payment of a prevalent additional late fee as prescribed by the Institute. Normally no late registration will be permitted after the 3rd working day from the scheduled date.

9.4 Only those students will be permitted to register who have :

(a) Made all required advance payments of Institute tuition fee, seat rent etc., and

(b) Hall dues for the current semester for which they are registering,

(c) Cleared all Institute and Hall dues of the previous semester,

(d) Has maintained the SGPA/CGPA requirement during the earlier semester(s) as mentioned in 12.4(a).

9.5 The students shall choose the subjects for registration in consultation with the Faculty Advisor.

9.6 A student may be allowed to become non-resident on the recommendation of the Faculty Adviser and the Head of the Department and with the approval of the Dean of Postgraduate Studies after successful and continuous completion of the full course work (theory/laboratory/seminar/workshop/ comprehensive viva-voce etc.) with a CGPA 6.0 and no failure. The withdrawing student shall have to complete the thesis/project work, submit the thesis and appear at the final viva-voce within 5 years of admission. Sponsored students and those who opt to become non-resident in

order to join service will either have to produce a letter from their employer stating that they can carry out the thesis/project work at the employing organization or rejoin the department to work on the project full time at a later date if the employing organization does not have the facility for execution of the project work.

Provided further that

(a) the student communicates in writing to the Head of the Department by the end of preceding June the intention to submit the dissertation,

(b) before submission of the dissertation the student delivers a Seminar talk on a date to be fixed by the Head of the Department/Centre and clears all outstanding dues, if any, to the Institute or to the Hall of Residence.

(c) the student has to pay the semester registration fee for third and fourth semesters and re-admission fee as may be prescribed by the Institute from time to time.

(d) the assessment of the dissertation and the conduct of the viva voce thereon will be arranged by the Head of the Department/Centre along with other regular students of the particular semester.

9.7 Students who discontinue their studies without prior permission before completing the first and second semester course work shall be deemed to have abandoned their studies and their names will be struck off the rolls of the Institute with effect from the date of absenting from the classes. A student who leaves the Institute without prior permission even during the 3rd or 4th semester shall also be treated to have discontinued and will be liable to similar action. Transcript/grade card for any unfinished course/programme of study will not be issued in such cases.

9.8 A student who has already registered may :

(a) Register for a new subject in addition to the subjects he/she has already registered for, or

(b) Opt for a new subject in place of the one already registered for, with the concurrence of the Faculty Adviser and the Head of the Department.

Any change of subject as permissible by sub-paras (a) and (b), above must however, be done within one week of registration.

(c) Such changes once made will be final and request for any further change/modification shall not be acceptable.

## 10. Grading System

10.1 A seven-scale letter grade system will be used to assess the performance of students in the various categories (subject, project, etc.) as follows

| Description | Letter grade | Grade points per Credit |
|---|---|---|
| Excellent | Ex | 10 |
| Very good | A | 9 |
| Good | B | 8 |
| Fair | C | 7 |
| Average | D | 6 |
| Pass | P | 5 |
| Fail | F | 0 |

The exceptionally brilliant performance is to be assigned an 'Ex' grade. Even the best student of any class needs to be good enough to be awarded the 'Ex' grade.

In addition, there shall be two transitional symbols used by Examiners.

I - for Incomplete X
- for Debarred.

10.2 A **Semester Grade Point Average** (SGPA) will be computed for each Semester to work out the overall performance of a student in that semester. The SGPA will be calculated as follows:

$$SGPA = \sum_{i=1}^{n} c_i g_i \quad \sum_{i i=1}^{n} C$$

Where: 'n' is the number of subjects registered for during the Semester, '$c_i$' is the number of Credits allotted to a particular subject, and '$g_i$' is the grade-points carried by the letter corresponding to the grade awarded to the student for that subject. SGPA will be rounded off to be second place of decimal and recorded as such. The SGPA would indicate the performance of the student in the semester to which it refers.

10.3 A **Cumulative Grade Point Average** (CGPA) will be computed at the end of the Second and the Thesis/Project semesters. The CGPA gives the cumulative performance of the student from the first semester up to the end of the semester to which it refers, and will be calculated as follows:

$$CGPA = \sum_{i=1}^{m} c_i g_i \quad \sum_{i i=1}^{m} C$$

Where 'm' is the total number of subjects the student has registered from the first semester onwards up to and including the semester S, '$c_i$' is the number of Credits allotted to a particular subject '$s_i$' and '$g_i$' is the grade-point carried by the letter corresponding to the grade awarded to the student for the subject '$s_i$' . CGPA will be rounded off to the second place of decimal and recorded as such.

The CGPA would indicate the cumulative performance of the student from the first semester up to the end of the semester to which it refers.

10.4 Whenever these Grade Point Averages are to be used for the purpose of determining the inter-se-merit ranking of a group of students, only the rounded off values will be taken into account.

10.5 When a student gets grade 'I' for any subject(s) during a semester, the SGPA for that semester and the CGPA will be tentatively calculated ignoring this subject. After the 'I' grade(s) has been replaced by a appropriate grade(s), the SGPA for that semester and the CGPA will finally be recalculated taking into account the performance in the subject(s) concerned.[For 'X' grade, see section 13.3 and 13.4]

10.6 When a student gets grade 'F' for any subject(s) during a semester, the SGPA and CGPA from that semester onwards will be tentatively calculated, taking only 'zero points' for each such 'F' grade. After the F grade(s) has been substituted by a higher grade in the supplementary examination or in a subsequent semester, the SGPA and CGPA of all the semesters, onwards from the semester in which 'F grade was obtained earlier, will be suitably modified to take this change of grade into account.

10.7 In the case of a relatively large class and/or classes where the performance level depicts more or less a normal distribution:

(a) The average performance (around mean value of marks) is to be assigned 'C' grade. However, if by teacher's/co-ordination committee's perception the general level of the class is considered to be appreciably high, the average performance may be assigned 'B' grade.

(b) All other marks to grade conversion are to be done relatively with respect to the average performance in between (but excluding) the 'F' and 'Ex' grades, which have already been assigned, by choosing appropriate boundary marks between grades.

(c) Normally, in a reasonably large class of students distribution of grades is expected to be as follows:

| | |
|---|---|
| Ex | < = 10 % |
| A | 10 - 20 % |
| B, C, D | 20 - 35 % |
| P | 10 - 25 % |
| F | < = 5 % |

(d) In the case where a student appears in the supplementary examination the conversion from marks to grade would be done applying the same norm as was framed for the original class.

(e) For classes where excessive bunching occurs resulting in all most all the marks tending to cluster into same category, conversion from marks to grade may be done using the table given below, where 'm' stands for the marks obtained. However, the teacher may, on his/her perception of the difficulty level of assessment process undertaken, alter the boundary (cut-off) marks by +/- 5 marks.

| Range of Marks | Grade |
|---|---|
| m >= 90 | Ex |
| 80 <= m < 90 | A |
| 70 <= m < 80 | B |
| 60 <= m < 70 | C |
| 50 <= m < 60 | D |
| 35 <= m < 50 | P for Theory Component |
| 40 <= m < 50 | P for Laboratory Component |
| m < 35 | F for Theory Component |
| m < 40 | F for Laboratory Component |

11. **Award of Grades**

11.1 There will be continuous assessment of a student's performance throughout the semester and grades will be awarded by the teacher concerned or by the appropriate committees appointed for the purpose on the basis of following:

(a) mid-semester and end-semester examination in the case of theoretical subjects,

(b) comprehensive viva voce,

(c) laboratory/design/workshop, thesis/project, seminars, dissertation and viva voce.

11.2 In the case of theoretical subjects:

(a) The concerned Department will conduct the mid-semester and end semester examinations,

(b) For theoretical subjects, the final grades will be awarded on the basis of Teacher's Assessment, Mid-Semester Examination and End-Semester Examination, according to the weightage given below:

| **Teacher's Assessment** (attendance, home assignment, asignments, class tests, tutorials etc.) | **Mid-Semester examination** | **End-Semester examination** |
|---|---|---|
| 20 | 30 | 50 |

(c) The final grades for a subject must be submitted to the Head of the Department by the teacher concerned within **five days** of the date on which the Semester Examination for that subject has been held.

11.3 For subjects like laboratory/design/drawing/workshop etc., the evaluation will be based on the weightage as shown below:

| | |
|---|---|
| Day-to-day work (Attendance and completion of practical/laboratory/ drawing-tasks assigned | 60 |
| At least 2 oral/practical/ drawing tests and or viva-voce | 40 |

11.4 A Seminar Assessment Committee will be formed by the Heads of the Departments for the evaluation of performance at Seminars. Every student who registers for 'Seminar' is expected to attend all the seminars of all the students of the batch held in the Department during the Semester. Due weightage will be given to a student's attendance in the overall evaluation of this requirement.

11.5 Viva-voce Boards will be constituted by the Head of the Department for conducting the comprehensive viva-voce.

12. **Examinations**

12.1 In case of theoretical subjects, there will be a mid-semester examination in about the middle of the Semester and an end-semester examination at the end of the semester. Normally, there will be no end-semester examination in the practical (i.e., Laboratory, Workshop etc.). However, if any test or final examination in Laboratory/Drawing/Workshop is held, its weightage should conform to section 11.3.

12.2 Students will be permitted to appear in the examinations of only those subjects for which they have registered themselves in the beginning of a semester.

12.3 The semester examination will carry specified weightage for the purpose of award of grades for subjects of various L-T-P loading {(vide para 11.2(b) above)}.

12.4 (a) A student will be required to discontinue his studies if he obtains - ***Either***,

(i) SGPA in the First (Autumn) Semester lower than 6.00 with grade 'F' in one or more subject(s)

***Or***,

(ii) CGPA at the end of the Second (Spring) Semester lower than 6.00 with grade 'F' in one or more subject(s)

***Or***,

(iii) Grade 'F' in more than two subjects in the First (Autumn) Semester, the Second (Spring) Semester, or the two Semesters taken together.

(b) Students obtaining :

(i) Grade 'P' or a higher grade in all the subjects and SGPA below 6.00 but not lower than 5.00 in the First (Autumn) Semester will be allowed to continue his studies, but he must improve his performance in the Second (Spring) Semester so that the deficiency in the overall requirement is made up.

(ii) SGPA/CGPA 6.00 or higher but grade 'F' in not more than 2 subjects in the First (Autumn) or the Second (Spring) Semester or both the Semesters taken together may be allowed to continue in the programme and register for the subsequent semester.

(c) The Institute assistantship of a student will be withheld in case a student fails in any subject. It will be restored only if SGPA/CGPA is at least 6.0 AND there is no 'F' grade following the supplementary examination. The student may however, continue without assistantship after supplementary examination with 'F' grade/grades, subject to the provisions contained in clause -12.4 (a).

(d) A student can appear for Supplementary Examination in the subject(s) concerned to be held in the Department within 1 month after the completion of the semester. In supplementary examination the student will be given one grade lower than the actual performance grade except in the case of grade 'P' which will remain unchanged. The student will apply in a prescribed form together with necessary fees in order to appear in the supplementary examination.

(e) Students with 'F' grades also have an option to re-register for the subject(s) in which they had failed in the following Autumn Semester or Spring Semester in which the subjects are offered. In such a case they will be entitled to full credit according to performance at the examination.

(f) Students who have obtained CGPA lower than 6.00 may be allowed, on the recommendation of the Head of the Department and with the approval of Dean to re-register in one or more subject(s) in which he/she has received 'P' grade(s), so as to improve his/her CGPA to 6.00 or above by registering in the subject in the semester whenever it is offered. The availability of the course/faculty and a slot in the time-table is to be ensured by the concerned student/faculty advisor before registration in such subject(s) for grade improvement. This additional facility in any way, will not effect the total duration of the programme and graduation requirement mentioned under the provisions of clause-14. The grades will be revised and recorded only if there is an improvement over the existing 'P' grade.

12.5 A student whose performance in any of the parts of the project work as prescribed in section 8 has been unsatisfactory, may be assigned additional work on the same problem or assigned a new problem. If the student is assigned additional work the student will have to complete the work and appear at the viva-voce as scheduled. If the student is assigned a new problem on account of any reason, the student will have to submit the dissertation and complete the viva-voce by October 31 of that calendar year. The student shall not be eligible for assistantship during the extended period of his stay but will have to pay project semester fees during the extended period of stay.

12.6 A student who has failed in the comprehensive viva-voce shall be required to present himself/herself again within a period of two months for the viva-voce on a date to be fixed by the Head of the Department/Centre. The student will be entitled to award of one grade lower than the actual performance in such cases. The student has to discontinue studies in the event of failing second time.

13. **The Incomplete Grade 'I' and Debarred Grade 'X'**

13.1(a) The grade 'I' may be temporarily given to a student who is unable to appear in the end-semester examination because of:

(i) illness or accident which disables the student from appearing in the examination. This must be duly certified by the institute Hospital.

(ii) a calamity in the family at the time of the examination which, in the opinion of the Head of the Department and Dean of Students Affairs required the student to be away from the campus.

(b) If a student is unable to appear at a mid-semester examination for any of the compelling reasons mentioned above, the teacher(s) concerned may use discretion, and take a test with same weightage.

13.2 (a) A student who has been awarded grade 'I' in a subject in the end-semester examination shall have the option to either,

(i) appear at a supplementary examination to be held by the Department by filling in the application in prescribed form together with payment of necessary fees. In the supplementary examination the student will be awarded one grade lower than the actual grade obtained from the performance in the examination, except in the case of grade 'P' which will remain unchanged, or

(ii) re-register for the subject in the subsequent semester in which it is offered. In such case the student is entitled to full credit in accordance with the performance.

(b) No supplementary examination will be held in laboratory subjects. The student has to re-register during a regular semester.

13.3 **Debarred Grade "X"**

A student who

(i) is absent for a major part of a semester, or

(ii) does not complete a major part of the laboratory/design/ workshop/seminar work etc. or

(iii) does not appear in the mid-semester examination without any acceptable ground, shall be awarded grade 'X' and he/she shall be debarred from appearing at the end semester examination of the corresponding subject(s).

13.4 A student who is debarred from appearing at an end-semester examination for reasons as specified by clause -13.3 will be required to re-register for the subject(s) in the next semester when they are offered by the Department/Centre, subject to other conditions of the regulations.

14. **Graduation Requirements**

14.1 In order to qualify for either M.Tech. degree of the Institute, a student must –

(a) have completed all the credit requirements for the degree, which is prescribed as minimum credits by the concerned Department with grade 'P' or a higher grade in each of the subjects etc., for which the student had registered in all the semesters,

(b) have obtained a CGPA of 6.00 or more at the end of the semester in which the student completes all the requirements (including the project dissertation/thesis), for the degree.

14.2 A student will be declared to have qualified for the degree in a session if the student completes all the requirements covering minimum credits specified by the concerned department by the 30th July when the session is closed, and will be admitted to the degree in the next annual convocation.

14.3 A student who has qualified for the degree will be admitted to it only after the student has cleared all Institute and Hostel dues, and has returned any inventory/instruments, departmental library books etc., outstanding in his/her name in good condition.

## 15 Withdrawal

15.1 A student who has been admitted to M.Tech. program may be permitted to withdraw temporarily for a period of one semester or more from the Institute on account of prolonged illness/acute problem in the family provided that:

(a) The student applies to the Institute within 15 days of commencement of the semester or from the date last attended the classes, stating fully the reasons for such withdrawal together with supporting documents and endorsement of the father/guardian,

(b) the Institute is satisfied that, inclusive of the period of withdrawal, the student is likely to complete all the requirements for the degree within 5 years of admission to the program,

(c) there are no outstanding dues or demands from the Institute/Department/Hostel/Library.

15.2 A student who has been granted temporary withdrawal under provisions of clause 15.1 will be required to pay tuition fee and other fees for the current semester registration when the student rejoins the program.

15.3 A student shall be granted only one such temporary withdrawal during the program.

## 16. Assistantships, Medals and Prizes

The Institute shall award Postgraduate Assistantships, Medals and Prizes in accordance with the provisions laid down in the rules at **Appendix-V**.

## 17. Relaxation

The Senate may, under exceptional circumstances, consider any case of a student having a minor deficiency in respect of any of the requirements stated in these regulations and relax the relevant provision of these regulations based on the merit of the case. The grounds on which such relaxation is granted shall invariably be recorded and cannot be cited as precedence.

**APPENDIX - I**

## RULES REGARDING ADMISSION OF SPONSORED CANDIDATES TO M.TECH. COURSES

**( Vide para 3.3 of the Regulation )**

1. The Institute may admit persons, who are in gainful employment as 'Sponsored Students' to any of the courses covered by this regulation, subject to the condition laid down in following paragraphs.

2. An applicant seeking admission as a sponsored candidate must have obtained at the qualifying degree examination with at least 60 % marks or equivalent CGPA in the case of Bachelor's degree examination in Engineering/Technology

3. Candidates who possess the minimum prescribed qualification and are in service in any of the following establishments shall be eligible for admission to the courses as sponsored students-

i. Defence or other ministries of the Government of India or any other Government organisation.

ii. Established industries, Research and Development Organizations as may be recognized by the Institute from time to time

iii. Autonomous public undertakings

iv. QIP Scheme of the Government of India

v. Universities and recognized technical institutions which are not covered by the QIP Scheme

4. Candidates seeking admission as sponsored students must have had a standing of at least 2 years service and while applying, shall have to produce evidence to the effect that :

a. they are on leave to study with full pay for the duration of the course, and

b. their services in the establishments concerned will be retained.

5. Intending sponsored candidates must submit their application on prescribed form for admission through their employers, a competent authority of which will forward the same to the Institute with suitable endorsements as required in the application form, so as to reach the Institute by the stipulated date.

6. All sponsored candidates shall be required to qualify in an interview by a selection committee to be appointed by the Departmental Academic Committee (PG & R) of the Department/Centre concerned. The provisions of this para shall not be applicable to the candidates selected for admission under Defence sponsorship of the Government of India.

7. A sponsored candidate selected for admission shall be required, at the time of joining the

Institute, to

a. produce certificates in a prescribed form from the employers to the effect that the applicant:-

(i.) has been in service there for at least a period of 2 years.

(ii) .has been officially released from duties for purpose of joining the course and that he/she will draw full pay during their period of study,

(iii.) services are retained with the employers.

b. submit evidence of having passed the qualifying examinations with required percentage of marks or grade and such other documents as the Institute may require.

**APPENDIX - II**

## RULES RELATING TO ENROLMENT OF NON-TEACHING STAFF MEMBERS OF THE INSTITUTE

**( Vide para 3.5 of the Regulation )**

1. Permanent members of non-teaching staff of the Institute may be permitted to join the M. Tech. program of the Institute provided that prior permission has been obtained from competent authority before applying for admission to the program.

2. For admission to the program a member of staff must have obtained at least the percentage of marks/grade/CGPA as prescribed to be the minimum requirement for sponsored candidates.

3. All common rules laid down in the M. Tech. regulations relating to course work, project work/thesis under the supervision of a member of faculty, etc., unless permitted otherwise, shall be applicable to such persons.

4. A member of staff enrolled for the M. Tech. degree shall be required to pay registration fee only, as applicable from time to time. Members of staff permitted and enrolled for the degree shall not be entitled to any Assistantship.

5. The other conditions for granting permission to the non-teaching staff to enroll in the M.Tech. program shall be as follows.

i.The applicant must hold a permanent (substantive) post in the Institute and must have a standing of at least 3 years' service in the post.

ii.The application for administrative permission to join the M. Tech. program by a member of non-teaching staff must be submitted through the Head of the Department or the Section In-charge, as the case may be. While submitting the application the applicant must give an undertaking in the form appended hereto **(Schedule-A)** to the effect that the applicant will abide by all rules and regulations.

iii. The maximum number of credits that can be taken by the employee in each semester shall be at the convenience of the Department. If the exigencies of Institute work so require, the permission granted can be withdrawn by the Institute at any time.

iv.All applications under this category shall be examined by the Postgraduate Programme & Evaluation Committee (PGPEC) taking into account whether the proposal for joining the program for which permission is sought for arises out of genuine interest and ability. After the permission is granted the person will submit application for admission together with the prescribed fee. The composition of the PGPEC includes Dean (Academic) as chairman, Dean (Students affairs) as convener, HoD and Registrar.

v.The minimum period to be spent for completion of the course work and submission of the dissertation/thesis by the candidate shall be 3 years from the date of registration. The maximum period however remain to be 5 years.

vi.A member of the non-teaching staff who has obtained a M.Tech. degree from the Institute under this clause shall have to serve the Institute for a period of 3 years after obtaining the degree.

**UNDERTAKING**

**SCHEDULE-A**

I, Mr./Ms.……..……. member of the non-teaching staff holding a permanent post of ……..…… ……..…… in the Department of ..... at the Indian Institute of Petroleum and Energy, Visakhapatnam, do hereby give the undertaking that I shall abide by the rules and regulations as may be laid down by the Senate of the Institute from time-to-time for undergoing the M.Tech. program. I also undertake hereby that since I shall be on duty while undergoing the program of study, I shall ensure that all normal official duties assigned to me are executed without any handicap. I further understand that the permission granted to me for joining the program can be withdrawn at any time if the exigencies of official duties so require or if I cause breach of any of the provisions of rules and regulations.

Date:……. …….

(Signature)

**APPENDIX - III**

## RULES RELATING TO RESIDENTIAL REQUIREMENTS

**( Vide para 4.2 of the Regulations )**

The following are the detailed rules governing residence requirements of students:

1. The mess of each Hall of Residence shall function as a single integrated unit and shall not, under any circumstances, be sub-divided into any kind of groups or sub-groups.

2. Under special circumstances, the Director/Dean may permit a student to reside with the parent/guardian in the Institute Campus or within a reasonable distance from the Institute. Such a student shall, however, be attached to a Hall of Residence and will be required to pay seat rent according to rules, and Hall establishment charges fixed by the Warden. However, this permission may be withdrawn at the discretion of the Institute, at any time considered appropriate by it, without assigning any reason.

3. Family accommodation may be provided to married students (Sponsored, QIP, Foreign nationals with Government Assistantship) of M.Tech courses, if available.

4. A student shall reside in a room allotted to him/her and may shift to any other room only under the direction/permission of the HMC - Chairman.

5. No student shall come into or give up residence in any Hall of Residence without the prior permission of the Warden and HMC-Chairman.

6. Students shall be required to make their rooms available whenever required for repairs, maintenance, disinfection, or inspection and shall be required to vacate the rooms when leaving for the vacations/holidays.

7. Students shall be responsible for the proper care of the furniture, fan and other fittings in the rooms allotted to them and shall generally assist the Warden in ensuring proper use, care and security of those provided in the Halls for common use of all students.

8. Students will be responsible for the safe keeping of their own property. In the event of loss of the personal property of a student due to theft, fire or any other cause, the Institute shall accept no responsibility and shall not be liable for payment of any compensation.

9. All students must abide by the rules and regulations of the Halls of Residence as may be framed from time to time.

10. Use of electrical appliances like heaters or ovens and cooking inside the rooms are strictly prohibited. Engaging personal attendants and keeping pets by a student in the Hall of Residence are debarred.

11. A student who has been permitted under the provisions of para 15.1 and para 15.2 of the Regulation to withdraw temporarily from the program must vacate the Hall of Residence, on the day of departure. Suitable accommodation may be re-allotted when the student rejoins the program.

**APPENDIX - IV**

## RULES REGARDING CONDUCT AND DISCIPLINE

**( Vide para 6.2 of the Regulations )**

Following rules shall be applicable to all students in the matters of conduct and discipline :

1. Students shall show due respect to the teachers of the Institute, the Wardens of the Halls of residence, the Sports Officers of the Gymkhana and the Officers of the National Cadet Corps; proper courtesy and consideration should be extended to the employees of the Institute and of the Halls of residence. They shall also pay due attention and courtesy to visitors.

2. Students are required to develop a friendly camaraderie with fellow students. In particular, they are expected to show kindness and consideration to the new students admitted to the Institute every year. Law bans ragging of new comers in any form. Acts of ragging will be considered as gross indiscipline and will be severely dealt with.

3. The following acts of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures

Ragging

Lack of courtesy and decorum; indecent behavior any where within or outside the campus

Willful damage or stealthy removal of any property/belongings of the Institute/ Hall or of fellow students

Possession, consumption or distribution of alcoholic drinks or any kind of hallucinogenic drug

Adoption of unfair means in the examinations

Mutilation or unauthorized possession of library books

Noisy and unseemly behavior, disturbing studies of fellow-students.

Commensurate with the gravity of the offence, the punishment may be reprimand, fine, expulsion from the Hall, debarment from an examination, rustication for a specified period or even outright expulsion from the Institute.

4. For an offence committed in :

a. the Hall of Residence,

b. the Department or in a classroom, and

c. elsewhere,

the Warden, the Head of the Department and the Dean of Students' Affairs, respectively, shall have the authority to reprimand or impose fine or take any other suitable measure.

5. All cases involving punishment other than reprimand shall be reported to the Chairman of the Standing Institute Conduct and Disciplinary Committee.

a. All major acts of indiscipline, which may have serious implications on the general body of students, and/or which may warrant a uniform and more formalized nature of investigation, shall be handled by the **Standing Institute Conduct and Disciplinary Committee**, appointed by the Senate.

The Standing Institute Conduct and Disciplinary Committee consists of the following ex-officio and other members

i. Dean of Students' Affairs - Chairman

ii. Chief warden / Chairman, HMC - Member

iii. Warden of concerned Hall of Residence - Member

iv. HOD of the concerned department - Member

v. Vice President, Technology Students' Gymkhana - Member

vi. One Senate member (nominated by the Senate by rotation for a term of 2 years - Member

vii PG student representative in Senate - Member

viii Deputy Registrar (Academic) - Member Secretary

b. Recommendations of the committee, which include the suggested quantum of punishment in cases of proven guilt, will be submitted for approval of the Chairman of the Senate.

6. Cases of adoption of unfair means in an examination shall be dealt with by the Head of the Departments concerned in consultation with the Invigilators and the Paper Setter. The Head of the Department shall recommend appropriate measures in each case to the Director who as Chairman of the Senate shall award the punishment and later report the matter to the Senate.

7.

(i) The Head of the Department may debar a student from appearing in an examination on any of the following grounds, if the student's

a. Attendance in the lecture/tutorial/practical/workshop/design/field visit/ project and seminar classes during the semester has been unsatisfactory;

b. Performance in the laboratory/workshop/design etc., and work done during the semester/project has not been satisfactory;

c. Conduct in the classes or in the Department/Centre has been unsatisfactory or the student has attempted to adopt unfair means at the examination;

(ii) A student may also be debarred from appearing at an examination if there is a written report from the Warden of the Hall of Residence to the effect that the student:

a. has not cleared the outstanding dues in the Hall;

b. has been involved in an act of misconduct or indiscipline;

c. has been involved in any such activity, which is/amounts to detrimental towards reputation and interests of the department/institute.

**APPENDIX - V**

**TERMS AND CONDITIONS FOR AWARD OF INSTITUTE POSTGRADUATE ASSISTANTSHIP, INSTITUTE MEDALS, PRIZES**

**( Vide para 16 of the Regulations)**

**I. Institute Postgraduate Assistantship**

1. All students admitted to any of the M.Tech. courses under section 3.1 of this Regulation shall be entitled to Institute Postgraduate Assistantship Provided that the first installment of assistantship shall be released only after satisfactory scrutiny of necessary documents supporting the students' eligibility for the assistantship. The students will have to submit all documents latest by the time of registration for the second semester.

2. The monthly value of the assistantship shall be as approved by the Board of Governors from time to time in accordance with the rules of the Government of India.

3. The Assistantship shall be tenable for a maximum period of 24 months subject to the provisions appearing hereinafter.

i. The award of a assistantship shall be made, in the first instance, for 12 months of the session (July to June following) and will remain valid till the month of next June provided the student maintains the requirement of attendance, conduct and discipline etc.

ii. The assistantship shall be released in the beginning only after the admission of a student has been confirmed on verification of all necessary testimonials and the student has been reported medically fit by the institute Hospital.

iii. Notwithstanding the provisions of the foregoing subparagraphs the assistantship for the first month shall be payable on pro-rata basis depending on the date of joining of a student.

iv. The last monthly installment of assistantship for the 24th month shall be payable in full irrespective of the date of final viva-voce of the Project Semester, provided the student does not join any paid employment or any other assistantship before the last day of the month.

v. In the case of a student who discontinues studies before completing the program, the assistantship shall be payable up to the date the student attends the classes or works in the Department.

vi. All the students who are receiving the assistantship shall carry out teaching assistance to the allotted faculty members for a duration of 8 hours per week.

4. A student who was permitted, after having successfully completed the course work barring the thesis/project work, to leave the Institute for purpose of joining services may be re-awarded the assistantship for the remaining part of the tenure of 24 months; provided that-

(i) the student submits on re-joining, an application for the resumption of assistantship enclosing a certificate of 'No Objection' from the employer. The student shall not draw any salary from the employer during continuance of the assistantship;

(ii) such application shall be granted at the discretion of the Institute on the basis of merit of the case.

5. In the event of a student being absent from the Department without obtaining prior permission/sanction there for and/or if the period of absence exceeds the limit of admissible leave as prescribed by para 5.3 of the rules, deductions may be made from the student's monthly installment of assistantship proportionately.

6. A student shall be required to abide by all instructions issued by the Institute from time to time concerning award/payment of assistantship. In the event the student is reported to be caught/proved adopting unfair means in the examination, laboratory tests etc., the disciplinary committee will have the option to decide stopping the payment of assistantship and any other contingency amount for such duration, as it may deem fit and approved by the Chairman, Senate.

7. No student shall be permitted to enjoy more than one assistantship or remuneration from any other source during the same period. In the event of an awardee becoming eligible for another scholarship from the Institute or any other source, the student will have the option to retain any of the awards according to the choice. In such a case the student will communicate the choice in writing to the Dean.

8. A student who has been admitted to the program as a sponsored candidate may also apply for, and be awarded at the discretion of the Dean, Institute Postgraduate assistantship subject to the condition that the student-

. possesses B.Tech. or equivalent degree, or has qualified at GATE and has a valid GATE score percentile not below the cut-off point of admission of regular students in the session for the Department concerned

i. produce a certificate of 'No Objection' from the employer, and

ii. there is a vacancy in sanctioned strength of the Department.

9. Method of selection for self-financing students will be the same as mentioned vide clause-3.2 of the regulation. Students will be eligible for assistantship in the event of a vacancy arising or any of the student under assistantship leaving the programe. The GATE percentile will be the criteria for considering assistantship.

**Guidelines for Granting Assistantship to Candidates Admitted without Assistantship**

As per the current provisions certain percentage of the candidates in M.Tech. programmes are admitted 'without assistantship'. Subsequent to their joining the programme, these candidates may be able to seek assistantship under certain conditions. Department below means Department/Centre/School as the case may be. Assistantship under this category is awarded as per provisions below :

i. Vacancy arises on account of a regular **candidate** with assistantship does not join the programme, or after joining the programme discontinues the programme, or asked to leave the programme, or takes withdrawal.

ii. An assistantship becoming available in a particular department is awarded to a claimant from that department only.

iii. Irrespective of the GATE paper or specialization the claimants with the highest GATE percentile will be awarded the assistantship.

iv. Before joining the programme if a candidate with assistantship takes withdrawal, the Chairman, Admission Committee will issue assistantship to the most eligible candidate(s) who was offered admission without assistantship in that department.

v. The Chairman Admissions Committee will make available for each department the 'eligible

serial order' of the candidates without assistantship at the beginning of the programme.

vi. The student will apply with the recommendation of the Head of the Department to the Dean for the award of the assistantship.

vii. The Dean will approve and grant assistantship on fulfillment of other terms and conditions as laid down in the rules and regulations of the Institute.

viii.The date of approval by the Dean will be the effective date for the award of assistantship.

## II. Institute Gold Medals, Silver Medals and Endowment Prizes

10. A student who fulfils the following general conditions shall be eligible for award of Medals as mentioned below

In order to be eligible for the award of Medals/Prizes-

i) He/she must have obtained a CGPA of 9.00 or higher at the end of the Semester for which the award is meant,

ii) He/she must have completed the four semesters of the program consecutively and uninterrupted,

iii) He/she must not have failed in a subject (theory, laboratory, comprehensive viva-voce or Seminar) at any stage of the postgraduate program,

iv) no disciplinary action should have been taken against the student during the course of the postgraduate program.

**Note** :(i) In the event of there being a tie between two or more students becoming eligible for an award all of them obtaining the same CGPA, their performance at the end of the preceding semester will be taken into consideration. In case the performance in the preceding semester also happens to be the same, the performance in the semester previous to that will be taken into account to break the tie. If the tie cannot be broken thus the eligible students will share the prize/medal.

(ii) On the recommendation of the Postgraduate Programme & Evaluation Committee (PGPEC) the Senate may decide, in view of the exigencies occurring in a year or situations arising what so ever, to award any medal/prize for that year or discontinue award or to consider conferment in any other form it considers appropriate.

11. The following are the Medals and prizes to be awarded by the Institute to the most eligible student :

a. **Institute Gold Medal** : A gold medal (**The Director's Gold Medal**) be awarded to the student who is adjudged to be academically best securing the highest CGPA at the end of the fourth semester, among the students completing M.Tech. courses in that year, subject to the condition that all other requirements as mentioned under para-9 were fulfilled.

b. **Institute Silver Medals :** One Silver Medal shall be awarded every year to the best outgoing postgraduate student (first in order of merit) of each Department provided that the number of students graduating in the session from the Department concerned is not less than 5 and that all other requirements as mentioned under para-10 were fulfilled.

**Acknowledgement:** IIPE acknowledges the use of documents prepared by the mentor

institute, IIT Kharagpur

# PhD REGULATIONS

INDIAN INSTITUTE OF PETROLEUM AND ENERGY (IIPE)
VISAKHAPATNAM

**CONTENTS**

**REGULATIONS**

## GENERAL

- IIPE provides facilities for research leading to the Degree of Doctor of Philosophy (PhD) in Science and Engineering.
- Candidates who have qualified for the award of Bachelor's / Master's degree from IIPE or any equivalent degree from other recognized institute or university (as approved by Equivalency board of IIPE) are eligible to apply for the PhD program of IIPE.
- Admission into all PhD programs will be made against advertisement unless or otherwise specified.

## REGULATIONS

### 1. Categories of Admission

Admission into PhD programs in Science and Engineering are given under the following categories after fulfilling the eligibility criteria mentioned in section 2. The Eligible candidates for PhD program in Science and Engineering can be considered in the following categories.

1.1. Full time: Candidates fulfilling any one of the following criteria can apply for the full time category.

1.1.1. Candidates eligible for IIPE fellowship.

1.1.2. Candidates holding a fellowship from a national agency (CSIR/UGC-NET, DST etc.)

1.1.3. Candidates working in a sponsored project in IIPE.

1.1.4. Candidates selected/ sponsored under the **Quality Improvement Program (QIP)** as per State and Central Govt. Human Resources Ministries/ Technical Education Boards.

1.2. Extramural: Candidates fulfilling the following criteria can apply for the Extramural category.

1.2.1. Candidates employed and sponsored by any public/ private sector organization, government industry/institution, Universities recognized by UGC/MHRD, Govt. of India, having R & D facilities recognized as 'Research Institution' by IIPE.

1.2.2. Candidates under the Extramural/ Sponsored category will carry out their research work under the supervision of a Co-Supervisor from the sponsoring institution and a Supervisor from IIPE or vice versa.

1.2.3. Candidates must have at least five years of experience after acquiring required qualifications for admission into PhD.

1.2.4. Candidates need to produce a NOC cum Sponsorship letter at the time of application.

1.3. Part time: Candidates can apply for part time PhD program in Science and Engineering after fulfilling the eligibility criteria provided in section 2.

1.3.1. Candidates working as permanent faculty of a reputed University or academic/research/ professional organization/ institution.

1.3.2. Candidates admitted under Part-time category must complete the course work with six months of residential requirement. The research scholar must complete the course and comprehensive requirement within one year.

1.3.3. Candidates must have at least five years of experience after acquiring the required qualifications.

1.3.4. Permanent technical staff members of IIPE fulfilling the eligibility criteria.

1.3.5. Candidates need to produce a NOC cum Sponsorship letter at the time of application

## 2. Eligibility

2.1. Full time PhD in Engineering: The minimum educational qualifications for admission to the full time PhD program of the Institute are as follows:

2.1.1. Candidates with a master's degree in Engineering or Technology after qualifying GATE with consistent first class record.

2.1.2. Candidates who are qualified for the award of bachelor's degree in Engineering or Technology with consistent first class record can be considered for admission into PhD program in a relevant discipline subject to the following conditions:

2.1.2.1. Candidates with B.Tech. degree with a minimum CGPA of 8 on a 10.0-point scale (or 75%) or with a valid GATE score.

2.2. Full time PhD in Sciences: The minimum educational qualifications for admission into full time PhD in Sciences are as follows:

2.2.1. Candidates Master's degree in Sciences / Engineering / Technology with consistent first class record and a valid GATE or UGC or CSIR-NET or NBHM or equivalent score tenable for the year of admission in the relevant area.

2.2.2. Candidates with a master's degree in Engineering or Technology after qualifying GATE with a consistent first class record is eligible.

2.2.3. Candidates who are qualified for the award of bachelor's degree in Engineering or Technology with exceptionally good academic record can be considered for admission into PhD program in a relevant discipline subject to the following conditions:

2.2.3.1. Candidates with B.Tech. degree with a minimum CGPA of 8 on a 10.0-point scale (or 75%) and with a valid GATE score.

2.3. QIP candidates in Engineering and Sciences:

2.3.1. Candidates fulfilling qualifications mentioned in 2.1 and 2.2 and selected/ sponsored under the **Quality Improvement Program (QIP)** as per State and Central Govt. Human Resources Ministries/ Technical Education Boards.

2.4. Extra Mural and Part-time candidates in Engineering and Sciences:

2.4.1. Candidates fulfilling qualifications mentioned in 2.1 and 2.2 and valid GATE or UGC or CSIR-NET or NBHM can apply for PhD in a relevant Engineering/ Technology/ Science,

2.4.2. Candidates must be permanent staff members with at least five years of experience after the required qualification.

2.5. International Students

2.5.1. A foreign national can only register as a full-time research scholar.

2.5.2. A foreign national with a degree from Indian Universities will be treated on par with an Indian national for admission purposes.

2.5.3. Candidates with a foreign degree must meet the minimum educational requirements as given in 2.1 and 2.2 equivalent to candidates with Indian degree in the relevant disciplines.

In addition, they should have a valid GRE or GATE or UGC or CSIR-NET or NBHM or equivalent score. They should also have cleared the TOEFL/English Proficiency Test.

## 3. Eligibility for SC/ST

3.1. Candidates with 55% marks / 6 CGPA are eligible to apply for PhD after Master's degree.

3.2. Candidates CGPA of 7.0 (65%) are eligible to apply for PhD after with BTech degree with a valid GATE score.

## 4. Selection Procedure

4.1. Eligible candidates possessing the minimum educational qualifications and criteria set for different categories of PhD will write the entrance test. Those who qualify for the entrance test will be called for an interview.

4.2. Based on the performance of the candidates in the written test and interview, the Departmental Selection Committee will provide the merit list to the **Dean Research** for final selection.

## 5. Admission

5.1. Candidates whose selection has been approved by the Dean Research will be admitted into the PhD program after obtaining a medical fitness certificate as per the norms of IIPE and payment of prescribed fees.

## 6. Choice of Supervisor

6.1. After mutual discussion, the names of the potential Supervisors in the order of preference and their signatures will be submitted to the HoD.

6.2. Allotment of candidates to faculties will be made by the Departmental selection committee taking into consideration the research profile of the department and the preferences of the candidates and Supervisors.

6.3. There shall be no more than two Supervisors from the Institute for a candidate.

6.4. Additional Supervisor from outside the Institute can be allowed with the approval of the Director.

6.5. Co-Supervisor from other Institutions / Industries / IITs with a minimum academic qualification of PhD in relevant area may be nominated for PhD scholars on the request of Supervisor subject to approval of the Director.

6.6. Appointment of Co-Supervisor by the HoD on the recommendation of the Supervisor within 24 months from the date of joining for the PhD scholars.

6.7. The recommendation for inclusion of co-Supervisor after 24 months of the students joining the program, shall be made with valid reasons and justifications by the DAC of the candidate.

6.8. Co-Supervisor for PhD scholars can be appointed within the time limit (24 months).

6.9. In case the main Supervisor resigns and join other institute, the DAC will decide another Supervisor from relevant research field and the former Supervisor can act as co-Supervisor from his/her current institute.

6.10. The **DAC** will verify the CV of the proposed co-Supervisor and recommend appointment of the co- Supervisor if found eligible.

6.11. The co-Supervisor will be requested to sign intellectual property rights (IPR) and non-disclosure agreement (NDA) documents as a part of acceptance.

6.12. From a financial point of view the Institute should have no obligation to the Co-Supervisor.

## 7. Eligibility for being Supervisors

7.1. The following may be a Supervisor for a PhD scholar:

7.1.1. All faculty members of the Institute with a PhD in Engineering/Sciences.

7.1.2. Continuance of retired faculty members / emeritus faculty as Supervisors.

7.1.3. When a faculty member, who has guided a candidate for at least 3 years, retires, he will continue to be a Supervisor. However, a co-Supervisor who is in service will be appointed in addition.

7.1.4. A faculty member who is to retire within 3 years may be permitted to become a Supervisor to a new scholar with another faculty member, who is not likely to retire within 5 years as co-Supervisor, at the time of registration itself. Upon retirement, the faculty member will continue to be a Supervisor and will be invited to the Doctoral Advisory Committee (DAC) meetings, synopsis meeting and viva voce examination.

7.1.5. CSIR and other Emeritus Fellows / Scientists / Emeritus Professors, who hold office at this Institute for a period of 2 years or more, can become co-Supervisors for scholars along with a Supervisor from IIPE, with at least 5 years service still left at the time of registration of the scholar.

7.2. In case a faculty member who is a Supervisor goes on leave exceeding one year duration, another faculty member will be identified to become a co-Supervisor of the candidate.

7.3. Co-Supervisor for PhD scholars can be appointed from foreign / Indian universities within the time limit approved (24 months).

## 8. Change/Addition of Supervisor

8.1. The Doctoral Advisory Committee (DAC) of a candidate may recommend a change of Supervisor or appointment of a co-Supervisor for valid reasons.

## 9. Doctoral Advisory Committee (DAC)

9.1. For each research scholar, the HoD will be intimate to the Dean Research, the area of research, the name(s) of the Supervisor(s) and a panel of faculty names, for constitution of a **DAC**, within 8 weeks of the date of joining of the candidate.

9.2. The following is the composition of the DAC:

9.2.1. HoD, or nominee of the HoD. If the HoD happens to be the Supervisor of a scholar, the senior most Professor / previous HoD or will be nominated in the place of HoD.

9.2.2. DAC Chairman: HoD may nominate DAC Chairman for the scholar for the conduct of DAC meetings to assess the progress of the scholars.

9.2.3. Members

9.2.3.1. Research Supervisor or Supervisors

9.2.3.2. Minimum of two faculty members of the Department nominated by the Supervisor, approved by DAC chairman.

9.2.3.3. Minimum of one faculty member of allied Departments or allied Institutions

nominated by the DAC Chairman.

9.2.4. In case any member goes on leave exceeding one year duration, or resigns or retires from the Institute, the DAC Chairman will nominate another member.

9.2.5. Scientific/Design staff and others who are eligible to be Supervisor of PhD scholars may be nominated as members of the DAC.

9.2.6. Appointment of DAC members from abroad can be made with the condition that non-disclosure agreement to be obtained from the proposed DAC members before appointment.

9.2.7. For comprehensive viva meeting HoD is to be the Chairman.

9.2.8. Supervisor will act as a convener of the DAC meetings except for comprehensive viva.

## 10. DAC Proceedings

10.1. Research Proposal and Course Approval meeting

10.1.1. The DAC will consider/approve the proposed research topic and prescribe/approve the courses of study normally within a month of being constituted.

10.2. Comprehensive Examination after completion of minimum course work requirement

10.2.1. Every PhD scholar shall take and perform satisfactorily in a Comprehensive Examination in his/her Department.

10.2.2. The mode of the comprehensive exam shall be decided by the department.

10.2.3. The Comprehensive Examination shall be conducted by a Comprehensive Examination Committee of the Department, consisting of the DAC of the scholar and at least two other faculty members of the Institute nominated by the DAC Chairman.

10.2.4. If the performance of a candidate in the Comprehensive Examination in the first attempt is not satisfactory, he/she will be given one more opportunity to appear for the comprehensive examination within six months of the first attempt.

10.2.5. The registration of a candidate who fails to successfully complete the Comprehensive Examination in both attempts, his/her registration will be cancelled.

10.2.6. The objective of the Comprehensive Examination is to test the general capability of the candidate and the breadth of his/her knowledge in his/her discipline and areas related to his/her field of research.

10.2.7. The Comprehensive Examination Committee shall intimate to the candidate sufficiently in advance the scope of the Comprehensive Examination, to enable the scholar to prepare adequately for it.

10.2.8. The PhD candidates are normally expected to successfully complete the Comprehensive Examination within a year after his/her registration in the PhD program and in any case not later than three semesters after his registration in the PhD program.

10.2.9. Both written and oral components for Comprehensive viva can be allowed as decided by the Institute.

10.2.10. Comprehensive Examination to be completed by the Scholars in the following time:

10.2.10.1. Full time/Part time/Extramural after a Masters degree: within a year but not later than 3 semesters

10.2.10.2. Direct PhD after a Bachelor's degree: within 5 semesters

10.3. Candidature Confirmation Seminar (Seminar 1)

10.3.1. After successful completion of comprehensive examination, candidature confirmation seminar shall be conducted within a year in the form of 1st seminar.

10.4. Enhancement Seminar (Seminar 2)

10.4.1. After 2 years of joining and after successful completion of candidature confirmation

seminar, Enhancement seminar shall be conducted as per norms.

10.5. Further progress of research work

10.5.1. The DAC will meet again, where the candidate will make a presentation on the progress and plan of the research work.

## 11. Course Work

11.1. The DAC will normally prescribe two core courses and at least four electives. The prescribed courses shall be post-graduate level courses of the Institute.

11.2. PhD candidate in the Engineering / Sciences shall complete two core courses and at least two electives (minimum 12 credits).

11.3. In cases where the scholar is directly admitted to the PhD Program in Engineering with a Bachelor's degree in Engineering/ Technology or with a Master's degree in science where eligible to the PhD program, the scholar should successfully complete 5 core courses and 3 electives (minimum 26 credits) out of a minimum 5 prescribed by the DAC.

11.4. The DAC may give credit to courses already undergone by a candidate in this Institute or other Institutions, provided they are the same or equivalent to those prescribed, and the performance level of the scholar in them meets the minimum requirements.

11.5. The DAC may prescribe additional courses for candidates wherever found necessary. UG courses suggested by DAC may be allowed as audit courses.

11.6. Credit to courses already undergone by a candidate in this Institute or other Institutions may be considered if they were credited for award of any previous degree/diploma.

11.7. Waiver of one or more courses out of those prescribed by the PhD Ordinances and Regulations in exceptional cases by the DAC is not advisable.

## 12. Grades

12.1. Based on the semester performance, each PhD scholar is awarded a final grade at the end of the semester in each subject following the grading system of IIPE.

12.2. Candidates shall obtain a minimum CGPA of 7.5 in the courses taken by them subject to a minimum of "C" grade in the prescribed courses. If more than the minimum required electives have been taken, only the electives with the best performance will be considered for computing the CGPA.

12.3. Once a subject is successfully completed with grade higher than or equal to C, it cannot be repeated.

## 13. Progress Report

13.1. A candidate shall, after registration, submit annually a written report. Students are to submit a progress report to the Supervisor, HoD, DAC members every year.

13.2. The report should be routed through the Supervisor to the HoD, for consideration by the DAC committee.

13.3. The progress made by a candidate shall be reviewed by the DAC once a year. Continuance of registration, and award/continuance of scholarship/ Research Assistantship will be based on the recommendation of the DAC members.

13.4. In the case of candidates under the external registration program or working on a part-time basis, the DAC committee will pay particular attention to the quantum of effort put in by the scholar. Inadequacy of effort/progress can be a reason for cancellation of registration.

## 14. Enrolment

14.1. All candidates who are in residence and whose registration for research degree is still in force are required to enroll in person each semester on the stipulated date till their submission of

thesis, on payment of the requisite fees. Those not in residence may pre-enroll in absentia during the stipulated period after payment of the requisite fees. The enrolment will be cancelled if the progress is not satisfactory.

**15. Minimum Residential Requirement**

15.1. The minimum period of study and research for regular full time candidates required at the Institute from the date of registration for the PhD. Program in engineering to the date of submission of PhD. thesis shall be 24 months for candidates with a Master's Degree in Engineering / Technology; 36 months for

15.1.1. candidates with a Master's Degree in the Sciences,

15.1.2. candidates directly admitted to the PhD Program with Bachelor's degree in Engineering / Technology

15.2. The minimum period of study and research for regular full time candidates from the date of registration for the PhD Program in Sciences to the date of submission of the PhD thesis shall be 24 months.

15.3. The minimum residential requirement for the PhD. Scholar under external registration and candidates working on a part-time basis not employed in the Institute is one semester.

15.4. Withdrawal from the regular program is permitted for a semester or longer for reasons of ill health or other valid grounds as duly recommended by DAC.

**16. Leave rules**

16.1. A candidate (PhD student) is required to carry out his/her research work regularly under the guidance of the Supervisor(s), without any interruption during the period he/she enjoys the assistantship.

16.2. A scholar shall be entitled to (i) casual leave of 15 days and (ii) medical leave of 15 days in a year counting from the date of joining the program. The HoD will be the sanctioning authority in such cases. Any leave not availed of shall not accumulate.

16.3. Married candidates admitted to the PhD of the IIPE shall, in addition to casual leave and medical leave be entitled to maternity/paternity leave as per Government of India rules if the request for the leave is supported by a medical certificate from a Registered Medical Practitioner. The Head of the Department will be the sanctioning authority in such cases.

16.4. Any absence over and above the admissible leave as prescribed above shall be without assistantship, which shall be deducted on a pro-rata basis for the days of such absence.

16.5. A candidate may, on the recommendation of the Supervisor and the HoD, be granted a leave without assistantship for a total period not exceeding three months, during the entire tenure of assistantship by the Dean of Postgraduate Studies.

16.6. In exceptional circumstances, the Dean Research may, on the recommendation of the DAC grant a candidate leave without assistantship for a period not exceeding 12 months in the entire period of his tenure for the purpose of accepting teaching/research assignment on a temporary basis provided the post accepted by candidate is in the same department or in an educational institution, R & D organization or an industry of repute. When a scholar is granted such leave without assistantship the enhancement of the value of assistantship shall be deferred for the appropriate period.

**17. Teaching assistantship**

17.1. PhD scholars are expected to be given teaching assistantship of 8 hours per week.

**18. Relief from PhD. program to take up job**

18.1. PhD. Scholars who got a job offer can get relief from the program, while keeping their registration alive on payment of the requisite fees every semester, on the following conditions:

18.1.1. Scholars who take up jobs will be relieved on their request, based on the

recommendations of DAC, if they have completed their

18.1.1.1. Minimum residential requirement

18.1.1.2. Course work

18.1.1.3. Comprehensive examination.

18.1.2. The renewal of their registration for every year/semester, however, will be considered only if the DAC finds his/her progress to be satisfactory and recommends continuance of registration.

**19. Maximum Duration of Program**

19.1. Regular PhD. candidates should submit the thesis within 5 years from the date of registration and Direct PhD and Upgraded PhD scholars should submit the thesis within 6 years from the date of registration.

19.2. The DAC may extend the period of submission of the thesis further 2 years with an additional year for

19.2.1. research scholars under QIP

19.2.2. Part time research scholars

19.2.3. Extramural research scholars

19.2.4. Part time candidates working on a part-time basis

19.2.5. maximum duration for women PhD Scholars who avail maternity leave, is 5 years + 2 years+ number of days of maternity leave (not exceeding 180 days).

**20. Withdrawal from the program**

20.1. A scholar may be permitted by Dean Research to withdraw from the program for a semester or longer for reasons of ill health or other valid grounds duly recommended by the DAC. Normally a scholar will be permitted to discontinue from the program only for a maximum continuous period of two semesters.

**21. Cancellation of Registration**

21.1. The registration of a candidate whose progress is not found to be satisfactory by the DAC or who has not enrolled is liable to be cancelled.

21.2. The registration of a candidate who has not submitted his/her thesis before the end of the maximum permissible period will be cancelled.

**22. Synopsis**

22.1. On satisfactory completion of the prescribed courses, the comprehensive examination and the research work, the scholar shall submit the requisite copies of the synopsis of his/her research work in the required format through the Supervisor(s) and HoD to the DAC and Dean Research for consideration.

22.2. The candidate shall present the synopsis before the DAC. The DAC will, if it approves the work reported in the synopsis, permit the candidate to submit the thesis and recommend a panel of at least eight examiners from outside the institute (Foreign universities)

22.3. The scholar should have at least two paper either published or accepted for publication in refereed journals of which one must be published in internationally reputed (SCI/SCIE/Scopus indexed) journal. The scholar should have at least one journal paper with he/she as the first author.

22.4. Prior to submission of the synopsis, the scholar is required to give at least two seminar talks on the topic of his/her research and the first seminar talk must be given before the end of third year.

22.5. The Research proposal meeting may be treated as the first seminar. In case of a separate seminar meeting, it will be treated as DAC meeting. There must be at least 6 months between two seminars.

22.6. Synopsis/5th year progress meetings to be held at Dean Research's Office and will be chaired by HoD

**23. Submission of Thesis**

23.1. The scholars should submit the synopsis along with thesis in hard and soft copy on the day of synopsis meeting. However, one month time will be given to improve the thesis if they want to change it. Otherwise, the thesis submitted will be treated as final version.

23.2. The candidate shall, within one month of acceptance of the Synopsis, submit requisite copies of the thesis and abstract of the thesis as stipulated.

23.3. The DAC may grant additional time beyond one month on request from the scholar for valid reasons.

23.4. The guidelines for use of anti-plagiarism software for the PhD thesis are as follows:

23.4.1. the scholars must certify that the software "Turnitin" or any other standard software / platform was used for checking against Plagiarism.

23.4.2. The Supervisor must ensure checking against plagiarism through any standard software before submission of PhD thesis and endorse the undertaking of the scholar.

23.5. The Supervisor may obtain a special relief from this checking from the Dean Research on grounds of IP implications or National Security, if applicable.

**24. Panel of Examiners**

24.1. Supervisor to send the list of examiners with 8 names of Indian and Foreign experts.

24.2. The thesis shall be referred to three examiners out of which one must be Indian with approval from the DAC at the synopsis meeting.

24.3. The Indian reviewer must attend the viva-voce in person. If he/she is unable to attend viva-voce in person, video conference must be arranged with an internal examiner nominated.

24.4. Request will be sent to the alternate examiner for PhD thesis review after completion of the time limit and after issuing a second reminder to the existing examiners. This procedure to be brought to the attention of examiners in the first letter of invitation sent to them.

**25. Thesis Report**

25.1. The examiner is expected to send the report on the thesis within two months from the date of receipt of the thesis.

25.2. If an examiner suggests resubmission of the thesis, after revision, the candidate will be allowed to resubmit the thesis within the time stipulated by the DAC failing which the revised thesis will not be accepted and his/her registration will be cancelled.

25.3. If two examiners report the thesis as not commended, the registration of the scholar shall stand cancelled.

25.4. If reports of two examiners declare the thesis as 'commended' the DAC will consider the reports and recommend conducting the viva voce examination. The viva voce examination will be conducted normally not earlier than two weeks from the date of the constitution of the viva voce board.

25.5. In all other cases, not covered by the above Regulations, the matter will be referred to the Dean Research for consideration.

**26. Viva Voce Examination**

26.1. The following is the composition of the viva voce Board:

26.1.1. Head of the Department

26.1.1.1. If HoD happens to be the Supervisor of the candidate the Senior most Professor / previous HoD, will be nominated by DAC Chairman and Dean Research.

26.1.2. The examiner of the thesis from within the country, or a specialist in the subject

nominated by the DAC Chairman, Dean Research from the panel of examiners approved by the DAC.

26.1.3. Research Supervisor(s)

26.1.4. An expert either from the Institute or outside from the panel approved by the DAC and nominated by the Dean Research.

26.2. DAC members of the candidate concerned will be invited to the viva voce.

26.3. The viva voce board will examine the scholar on his/her thesis work and evaluate his/her performance as satisfactory or otherwise.

26.4. The viva voce board will ensure that the scholar answers satisfactorily the questions raised by the thesis examiner(s).

26.5. E-copy of the thesis to be circulated prior to reports meetings and viva voce examination of the PhD. thesis. The reports are to be circulated to the DAC members along with a e-copy of the thesis and the response of the candidate as well as the modified e - thesis be circulated prior to the Viva voce / meeting

26.6. If the report of the viva voce board declares the performance of the candidate not satisfactory, he/she may be asked to reappear for viva voce at a later date (not earlier than a month and not later than six months from the date of the first viva voce).

26.7. On the second occasion, the viva voce board will also include the members of the DAC.

26.8. If the viva voce board on the second occasion also evaluates the performance of the candidate not satisfactory, the matter will be referred to Dean Research for a decision.

26.9. The viva voce board may also recommend revision to be made in the final version of the thesis after taking into consideration and suggestions of the examiners who evaluated the thesis and the discussion at the viva voce.

26.10. The Chairman of the viva voce board shall forward the thesis to the academic section certifying that the revisions recommended by the viva voce board, if any, have been incorporated in the copy of the thesis along with the report of the viva voce board.

26.11. All the candidates shall submit one copy of the final form of thesis and an electronic version in PDF format after the viva voce board recommends the award of the PhD degree.

26.12. The examiner's name can be appended in the final copy of the thesis only with the consent of the examiner.

## 27. Award of PhD Degree

27.1. If the performance of the candidate in the viva voce is satisfactory, he/she will be awarded PhD. degree on the recommendation of the Dean Research and with the approval of the Board of Governors of the Institute.

27.2. PhD. degree will be awarded after successfully completing the PhD. requirement.

## 28. Discipline

28.1. Every scholar is required to observe disciplined and decorous behavior both inside and outside the campus and should not indulge in any activity, which will tend to bring down the prestige of the Institute.

28.2. Any act of indiscipline of a scholar reported to the Dean Research will be referred to a Discipline and Welfare Committee.

28.3. The committee will investigate the charges and will recommend suitable punishment if it finds the charges substantiated.

28.4. The recommendation of the Committee will be considered by the Dean Research to take appropriate action.

28.5. The Dean Research will record the action taken.

28.6. Appeal: The scholar may go in for appeal to whose decision will be final.

## 29. Power to Modify

29.1. Notwithstanding all that has been stated above, the academic advisory committee and Board of Governors has the right to modify any of the above regulations from time to time.

# Incorporation of Additional Details in the Course Contents: B.Tech- Chemical Engineering

- The prerequisites, course objectives and learning outcomes are included in the updated course contents as per the format given below.
- The department seeks approval from the Senate.

**Course outline format:**

| Course Code: | Course Title | Credits |
|---|---|---|
| | | |

**Pre-Requisites:**

**Objective**:

**Course Outcomes:**

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

1.

2.

3.

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**Syllabus:**

**Text Books:**

1.

2.

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**Reference Books:**

1.

2.

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**This format is implemented for all the subjects. An example is given below.**

| **Course Code: BS20002** | **Fluid Mechanics & Multiphase Flow** | **Credits**<br><br>**3-1-0: 4** |
|---|---|---|

**Pre-Requisites:** None

**Objective**: To understand the basic concept of fluid flow and its application to chemical process industries including pipe flow, fluid machinery and agitation & mixing.

**Course Outcomes:**

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

1. Illustrate governing equations for various applications
2. Identify, formulate and solve the fluid dynamics problems using Boundary conditions
3. Apply fluid dynamics principles in Internal flows as well as External Flows
4. Analyze various problems involving fluid properties and shear forces resulting from Newtonian and non-Newtonian fluids
5. Evaluate fluid systems using the integral form of the continuity, momentum, and energy equation

**Syllabus:**

**Fundamental Concepts:** Definition of Fluid, Lagrangian and Eulerian methods of description; Velocity Field: Streamline and stream function, Vorticity, Stress Field; Rheology: Newtonian/non-Newtonian Fluids, Viscous/Inviscid, Laminar/Turbulent, Compressible/ Incompressible, Internal/External, Rotational/Irrotational.

**Fluid Statics:** Pressure variation in static fluids, manometer, capillary hydrostatics.

**Internal Incompressible Viscous Flow:** Macroscopic mass and momentum balance using integral control volume method, Euler & Bernoulli equations, Internal Incompressible Viscous Flow. Fully developed laminar flow in pipes, Couette and annular flows; Hagen Poiseulle Equation, Eddy viscosity, Universal velocity profile; Skin and Form Friction, friction factor and friction factor versus Reynolds number relation, Calculation of Head Losses in pipes and fittings, Converging and diverging nozzles, Solution of single and multi-path pipe flow systems.

**External Incompressible Viscous Flow:** Flow around immersed bodies, Drag and Lift, Drag coefficient.

**Flow measurement and fluid mechanics:** Valves, Pumps, Compressors, Flow meters (Head/Area): Venturi, Orifice, Rotameter.

**Hydrodynamics of two-phase flow:** Homogeneous flow model, Separated flow model, Bubble formation and dynamics, Mass bubbling and liquid entrainment.

**Text Books:**

1. Introduction to Fluid Mechanics by R. W. Fox & Alan T. McDonald, Wiley; 6th edition (2003)
2. Fundamentals of Multiphase Flow by C. E. Brennen, Cambridge University Press; 1st edition (2009)

**Reference Books:**

**1.** Fluid Dynamics and Heat Transfer by James G. Knudsen and Donald L. Katz, McGraw-Hill; First Edition (1958)

**2.** Coulson & Richardson's Chemical Engineering: Fluid Flow, Heat Transfer & Mass Transfer, Vol.1., Butterworth-Heinemann; 6th edition (1999).

# Chemical Engineering: B.Tech syllabus refinement

- Details of minor changes in the *Code modification, title changes*, and *refinement of the course contents* are given below
- The department seeks approval from the Senate

**Code modification to the B.Tech courses:**

| Semester | Course Title | Existing code | New code |
|---|---|---|---|
| III | Fluid Mechanics & Multiphase Flow | BS 20002 | CH20010 |
| IV | Fluid flow and design | BS 20008 | CH20008 |
| V | Instrumentation and process control | BS 30002 | CH 30011 |
| VI | Transport Phenomena | CH 40002 | CH 30012 |
| VI | Instrumentation and Process Control Laboratory | BS 30004 | CH 30013 |
| VII | Process Safety | BS 40001 | CH40002 |
| VIII | Process Modeling and Simulation | PE 40013 | CH 40013 |

**Course title changes to the B.Tech Courses:**

| Semester | Course code | Existing title | New title |
|---|---|---|---|
| IV | CH 20005 | Chemical Reaction Engineering | Chemical Reaction Engineering I |
| V | CH 30002 | Reaction Engineering II | Chemical Reaction Engineering II |
| VIII | CH 40009 | Air Pollution | Air Pollution Control |

**Credit changes to the Elective-V:**

| Semester | Subject | Existing credit | Proposed credit |
|---|---|---|---|
| VIII | Elective-V | 2-0-0: credit-2 | 3-0-0 credit:3 |

**Refinement to the course contents:**

**1.**

**Course Title : Chemical Engineering Thermodynamics**
**Course code : CH 20002**
**Semester: IV**

| Existing syllabus: | Propose course outline |
|---|---|
| Estimation of properties: Real fluids and their mixtures, Algorithms for computer aided property estimation, and their applications to chemical engineering processes. Heat effects of industrial reactions: Theory and applications. Multiphase processes and multi component equilibria; Chemical reaction equilibria; Thermodynamic analysis of real processes. | **Review** Basic concepts and scope of thermodynamics; First and Second laws of thermodynamics. Carnot's theorem, and Entropy. Applications of first law to close and open systems; PVT relations; Equations of state.<br><br>**Property estimation of real fluids:** Thermodynamic potentials, Maxwell's relations, Gibb's free energy as generating function; Residual properties; Phase equilibrium; Thermodynamic phase diagram; Heat and work interconversion devices. Algorithms for computer aided property estimation, and their applications to chemical engineering processes. |

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|---|---|
| | **Vapor-liquid Equilibrium (VLE):** Phase rule; simple models for VLE; Dew and bubble-point calculations; Flash calculations; Property estimation from VLE. Multiphase processes and multi component equilibria;<br><br>**Solution thermodynamics:** Properties of mixtures; Partial Molar properties; Fugacity; Ideal solutions; Excess properties; Activity coefficients; Models for excess Gibb's free energy.<br><br>**Chemical Reaction Equilibrium:** Application of equilibrium criteria to Chemical Reactions; Equilibrium constant; Effect of temperature and compositions; Phase rule for reacting systems. Heat effects of industrial reactions: Theory and applications. Thermodynamic analysis of real processes. |

**2.**

**Course Title: Chemical Process Technology**
**Course code : CH20004**
**Semester: IV**

| **Existing syllabus:** | **Propose course outline** |
|---|---|
| Scope of CPT in process industries; Introduction of CPT with reference to Indian resources, industries, trade and export potentials, small-scale industries and rural development.<br><br>Major process symbols, preparation of process flow diagrams, and piping and instrumentation diagrams. | **Introduction to chemical process technology**: Role of chemical industry in daily life, Structure of Chemical industry and its background, Raw materials and Energy sources picture of india, Chemical industries in india, Renewable energy<br><br>**Unit processes and Unit operations:** Mechanical operations, Fluid flow devices, |

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| Introduction to the following industries (including the special features of design and operation) : Fuel and industrial gases including natural gas; petrochemical and downstream industries (in brief); polymer industries; fertilizer industries; caustic-chlorine industries; coal based chemical industries; petroleum refining processes (in brief) and allied industries including additives; nitrogen and nitrogen derivatives industry; sulphur and sulphur derivatives industry; phosphorus and its derivatives industry; soap and detergent industry; pulp and paper industry; alcohols and allied chemicals industry; other important basic and specialty chemicals industry. | mass and heat transfer operations, chemical reactions and reactors<br><br>**Inorganic chemical process industries**: Sulphur and sulphuric acid industry, Industrial gases, Nitrogen industries, Phosphorous industries, Fertilizer industries, Chlor-Alkali industry, Cement and lime<br><br>**Natural product Industries**: Soaps and detergents, Pulp and Paper industry, Coal and chemicals, Petroleum<br><br>**Organic chemical process industries**: Petroleum refining process and chemicals from $C_1$, $C_2$, $C_3$, $C_4$ compounds<br><br>**Polymer Industries**: Polymerization Fundamentals, Polymerization technology and manufacture process of polymers<br><br>**Process software**: Demonstration of flowsheet in Aspen |

**3. Course Title: Computer aided Process Engineering**
**Course code: CH 30007**
**Semester: VI**

| **Existing syllabus:** | **Propose course outline** |
|---|---|
| Review of numerical methods using Chemical Engineering applications - solution of linear and nonlinear algebraic equations, solution of coupled ordinary differential equations using Matlab. Importance of VLE/ LLE calculations for process simulation. Process modeling and simulation, Information Flow diagram, modeling of different process equipment - heat exchangers, boilers, evaporator, L-L extraction, furnaces, flash drum, distillation, | **Introduction**: Introduction of computation techniques in chemical engineering, demonstration of MATLAB with basic examples.<br><br>**Review** of numerical methods - convergence techniques, solution of linear and non-linear algebraic equations, solution of coupled ordinary differential equations.<br><br>Computational aspect in solving different processes using different numerical |

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|---|---|
| absorption, other staged / differential contacting processes, reactors etc. Process flow sheeting and simulators - Simulator components and structures, Salient features of simulators like ASPEN etc. Industrial Automation-Real time systems. | techniques- i.e., VLE/LLE calculations- Ideal and non-ideal VLE (Txy-Pxy plots, Azeotrope), Pressure drop in piping network, dynamic simulation of heat transfer equipment, distillation and absorption column, reactors etc.<br><br>**Unit operations and Unit process calculations by Aspen**: Property estimation methods in Aspen, Flash distillation and continuous binary distillation with reflux, Heat exchange equipment, boilers, evaporator, L-L extraction, absorption, reactors, reactor-separator problem, design specification and sensitivity analysis. |

**4.**

**Course Title : Advanced Separations (Elective II)**
**Course code : CH 40004**
**Semester: VII**

| **Existing syllabus:** | **Propose course outline** |
|---|---|
| Thermodynamics: Phase equilibria, non-ideal thermodynamic property models, activity coefficient models for the liquid phase; Single equilibrium stages: Multicomponent Liquid-Liquid, Solid-Liquid, Gas-Liquid, Vapor-Liquid-Liquid systems. Multicomponent multistage separations: Approximate methods, Equation tearing procedures. Enhanced distillation; Supercritical extraction. Vapor-liquid flow pattern and rate based models for distillation. Membrane separations; Adsorption, ion exchange, and chromatography | **Advanced Distillation Processes:** Review of Distillation; Steam Distillation; Complex Distillation Processes; Azeotropic Distillation; Homogeneous and Heterogeneous Systems; Pressure Swing distillation; Extractive Distillation with Entrainers; Multicomponent Distillation: Approximate method, Rate Based Method, Equation Tearing Procedure.<br><br>**Membranes separation processes for gas mixtures:** Membrane Structures, Transport across membranes, Different configurations |

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|---|---|
| | of membranes, Modeling aspects: product purity and yield;<br><br>**Membranes separation processes for liquids:** Microfiltration, ultrafiltration, Nanofiltration, Cross-flow, Batch Cell, Module design. Introduction, Theory, Design of Dialysis, Liquid Membranes, Pervaporation and Reverse Osmosis.<br><br>**Other Separation Processes**: Adsorption (PSA, TSA, advanced processes, modeling), Ion Exchange, Chromatography; Centrifugal separation, Electrophoretic separation, Micellar enhanced separation. |

**5. Course Title: Data Analytics and AI for Process Industry**

**Course code : BS40002**

**Semester: VII**

| **Existing Syllabus** | **Proposed course outline** |
|---|---|
| Introduction: Introduction to Data Analytics and Artificial Intelligence- Some illustrations of AI problems-Data-Information-Knowledge-Applications of Data Analytics-Introduction to the Languages of Data Science: R, SQL, and Python.<br><br>Data warehousing: Introduction to Data warehousing, Concepts of Data warehousing-OLAP-Data Preparation and Visualization.<br><br>Descriptive Statistics: Central Tendency and Variability, Inferential Statistics-Probability-Central Limit Theorem-Exploratory Data Analysis-Hypothesis Testing-Linear Regression | 1. **Introduction:** Introduction to Data Analytics and Artificial Intelligence-Some illustrations of AI problems-Data-Information-Knowledge-Applications of Data Analytics-Introduction to the Languages of Data Science: R, SQL, and Python.<br>2. **Data warehousing:** Introduction to Data warehousing, Concepts of Data warehousing-OLAP-Data Preparation and Visualization.<br>3. **Descriptive Statistics:** Central Tendency and Variability, Inferential Statistics-Probability-Central Limit Theorem-Exploratory Data Analysis-Hypothesis Testing-<br>4. **Linear Regression**<br>5. Classification and Clustering Techniques: KNN, Naïve Bayes and Logistic Regression-K-means and |

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|---|---|
| Classification: KNN, Naïve Bayes and Logistic Regression-K-means and Hierarchical ClusteringDecision Trees-Support Vector Machines-Neural Networks-Association Rule Mining.<br><br>Classification: KNN, Naïve Bayes and Logistic Regression-K-means and Hierarchical ClusteringDecision Trees-Support Vector Machines-Neural Networks-Association Rule Mining. Introduction to Big Data and Hadoop: Managing Big Data-Hadoop Ecosystem Tools (Sqoop and Hive)<br><br>Introduction to Spark: Big Data Analysis using SparkR-SparkSQL-Case studies | Hierarchical Clustering-Decision Trees-Support Vector Machines-Neural Networks-Association Rule Mining.<br>6. **Introduction to Big Data and Hadoop:** Managing Big Data-Hadoop Ecosystem Tools (Sqoop and Hive) |

**6.**

**Course Title : Instrumentation and Process Control Laboratory**
**Course code : BS 30004**
**Semester: VI**

| **Existing syllabus:** | **Propose course outline** |
|---|---|
| Calibration experiments on thermocouple, resistance thermometer, thermistor. Study and calibration of flapper nozzle assembly, pneumatic and electronic DP transmitter, I/P and P/I converters. Studies on control valve characteristics. Experiments on Dynamic behavior for interacting and non-interacting tank level systems, and temperature control (integrated system). Control performance studies on pressure process, tank level system, heat exchanger. | Response of thermometer without thermal well, Response of thermometer with thermal well, Calibration and response of thermocouple, Calibration and response of resistance thermometer, Control valve characteristics, Response of single tank level system, Response of two-tank interacting tank level system, Response of two-tank non-interacting tank level system, and temperature of control(integrated system), Response of manometer, Studies on hysteresis characteristics of Bourdon-Pressure Gauge, Control performance studies on pressure process, tank level system, heat exchanger. |

**7.**

**Course Title : Process Integration and System Design**
**Course code : CH 40005**

**Semester: VIII**

| **Existing syllabus:** | **Propose course outline** |
|---|---|
| Process Flow Sheet in Aspen plus and Aspen HYSYS.<br><br>Pinch technology and its application; Heat exchanger networks: analysis and design for maximum energy recovery, Loop Breaking & Path Relaxation, targeting of energy, area, number of units and cost, Trading off energy against capital.<br><br>Network Integration: Super targeting, maximum energy recovery, multiple utilities and multiple pinches, Grand Composite curve.<br><br>Mass integration: Distillation sequences. Graphical and numerical targeting methods of mass exchanger network.<br><br>Water integration, targeting and network design. Property integration.<br>Introduction to optimization; Separation scheme synthesis and residue curve theory; Nonlinear programming, mixed integer and disjunctive programming, flow sheet optimization;<br>Scheduling of batch and continuous multistage plants. Case Studies: Refinery scheduling and blending, multi-site production-planning. Supply chain optimization. | Introduction to chemical process design: types of chemical products, Process synthesis, Process simulation and optimization steps in the integrated chemical process design; Basics of optimization: components of an optimization problem and types of optimization problems.<br><br>Review of ASPEN Plus; Development and simulation of process flowsheet in Aspen plus.<br><br>Introduction to Pinch technology and its applications; Heat Integration: Steps in heat integration of chemical process plants; Targeting: Graphical and algebraic methods of targeting of energy, area, number of units and cost.<br><br>Design of Heat exchanger networks: analysis and design for maximum energy recovery, minimum area, minimum number of units; Concepts of Loop Breaking & Path Relaxation for optimizing the heat exchanger networks.<br><br>Costing of heat exchanger networks: Networks with similar materials of construction, networks with special materials of construction.<br><br>Network Integration: Super targeting, maximum energy recovery, multiple utilities and<br>multiple pinches, Grand Composite curve. |

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|---|---|
| | Mass integration: Distillation sequences. Graphical and numerical targeting methods of mass exchanger network. |

**8. Course title: Process Modeling and simulation**

**Couse code: CH 40013**
**Semester: VIII**

| **Existing syllabus:** | **Propose course outline** |
|---|---|
| ● Introduction: fundamentals of process modeling and simulations. Review of analytical and numerical techniques. Macroscopic mass, momentum and energy balances. Microscopic balances for mass, energy, and momentum, and associated constitutive relationships. Steady state and unsteady state modeling of chemical process equipment: flow systems, separators, reactors and heat exchangers. Grid generation; Introduction to SIMPLE, PISO. Finite volume approach. Introduction to simulators: Ansys Fluent, Open Foam.<br>● Formation of lumped parameter models, absolute and deviation variables, linearization, transfer function models, introduction to MATLAB Simulink.<br>● Modelling of disperse phase systems. Application of population balances in modelling particulate/disperse phase systems. Modelling of crystallizers, liquid-liquid extraction, polymerization reactors etc. | Introduction to modeling, a systematic approach to model building, classification of models. Conservation principles, thermodynamic principles of process systems.<br><br>Development of steady state and dynamic lumped and distributed parameter models based on first principles. Analysis of ill-conditioned systems.<br><br>Development of grey box models. Empirical model building. Statistical model calibration and validation. Population balance models. Examples.<br><br>Solution strategies for lumped parameter models. Stiff differential equations. Solution methods for initial value and boundary value problems. Euler's method. R-K method, shooting method, finite difference methods. Solving the problems using *MATLAB/SCILAB.* |

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|---|---|
| Introduction to stochastic processes. Modelling of stochastic processes using Kinetic Monte Carlo simulation. Modelling of mixing. Effect of mixing on conversion and yield of reactions. | Solution strategies for distributed parameter models. Solving parabolic, elliptic and hyperbolic partial differential equations. Finite element and finite volume methods |