

COURSE SCHEME
EXAMINATION SCHEME
ABSORPTION SCHEME
&
SYLLABUS

Of

First, Second, Third & Fourth Semester
Choice Base Credit System (CBCS)

Of

Master of Technology (M.Tech)

In

CHEMICAL TECHNOLOGY

Of

RASHTRASANT TUKDOJI MAHARAJ
NAGPUR UNIVERSITY, NAGPUR

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FIRST SEMESTER M.TECH (C.B.C.S.) (FOOD TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 101T/1 | Chemistry & Biochemistry of Food Components | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGCHT 102T/1 | Food Product Development & Packaging | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 103T/1 | Bioprocess Engineering | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 4. | PGCHT 104T/1 | Elective-I | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 5. | PGOPEN 105T | Elective-II | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 6. | PGCHT 106P/1 | Food Technology Practical | - | 4 | - | 4 | - | 2 | - | 2 | - | - | 100 | 100 | 200 |
| Total | | | 20 | 4 | - | 24 | 20 | 2 | - | 22 | 150 | 350 | 100 | 100 | 700 |

| Elective | | | |
|----------------------------------|--|------------------------------------|--------------------------|
| Elective-I (Discipline Specific) | 1. Advances in Food Engineering | 2. Molecular Biology | 3. Advances in Nutrition |
| Elective-II (Open) | 1. Chemical Engineering Mathematics | 2. Modern Chemical Instrumentation | |

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
SECOND SEMESTER M.TECH (C.B.C.S.) (FOOD TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---------------------------------------|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 201T/1 | Advances in Food Science & Technology | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGCHT 202T/1 | Food Biotechnology | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 203T/1 | Food Safety & Food Regulations | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 4. | PGCHT 204T/1 | Elective III | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 5. | PGFD205T | Research Methodology | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 6. | PGCHT206P | Seminar | - | 4 | - | 4 | - | 2 | - | 2 | - | - | 100 | 100 | 200 |
| Total | | | 20 | 4 | - | 24 | 20 | 2 | - | 22 | 150 | 350 | 100 | 100 | 700 |

| Elective | Subject Name | | |
|------------------------------------|-----------------------------------|----------------------|--|
| Elective-III (Discipline Specific) | 1. Food Industry Waste Management | 2. Enzyme Technology | |

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
THIRD SEMESTER M.TECH (C.B.C.S.) (FOOD TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---------------------------------|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGOPEN 301T | Elective IV | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGFD 302T | Project Planning and Management | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 303P | *Project Seminar | - | 3 | - | 3 | - | 8 | - | 8 | - | - | 100 | 100 | 200 |
| Total | | | 8 | 3 | - | 11 | 8 | 8 | - | 16 | 60 | 140 | 100 | 100 | 400 |

| | | | | |
|--------------------|--------------------------------|-------------------|--|--|
| Elective-IV (Open) | 1. Advanced Petroleum Refining | 2. Nanotechnology | | |
|--------------------|--------------------------------|-------------------|--|--|

*For Work Load: 2 Hours/week/faculty

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FOURTH SEMESTER M.TECH (C.B.C.S.) (FOOD TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|----------|----------|---|---|-------|--------|----|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 401P | *Project | - | 6 | - | 6 | - | 16 | - | 16 | - | - | 200 | 200 | 400 |
| Total | | | - | 6 | - | 6 | - | 16 | - | 16 | - | - | 200 | 200 | 400 |

* For Work Load: 3 Hours/week/faculty

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FIRST SEMESTER M.TECH (C.B.C.S.) (PETROCHEMICAL TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---------------------------------|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 101T/2 | Catalyst Science and Technology | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGCHT 102T/2 | Petroleum Refinery Engineering | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 103T/2 | Petrochemical Process Design | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 4. | PGCHT 104T/2 | Elective-I | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 5. | PGOPEN 105T | Elective-II | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 6. | PGCHT 106P/2 | Process Simulation Laboratory | - | 4 | - | 4 | - | 2 | - | 2 | - | - | 100 | 100 | 200 |
| Total | | | 20 | 4 | - | 24 | 20 | 2 | - | 22 | 150 | 350 | 100 | 100 | 700 |

| Elective | | | | |
|----------------------------------|-------------------------------------|---|---------------------------------|----------------------------|
| Elective-I (Discipline Specific) | 1. Oil & Natural Gas Processing | 2. Modelling & Simulation in Chemical Engineering | 3. Advanced Transport Phenomena | 4. Advanced Thermodynamics |
| Elective-II (Open) | 1. Chemical Engineering Mathematics | 2. Modern Chemical Instrumentation | | |

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
SECOND SEMESTER M.TECH (C.B.C.S.) (PETROCHEMICAL TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|-------------------------------------|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 201T/2 | Multicomponent Distillation | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGCHT 202T/2 | Process Equipment and Piping Design | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 203T/2 | Petroleum Specialty Products | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 4. | PGCHT 204T/2 | Elective III | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 5. | PGFD205T | Research Methodology | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 6. | PGCHT206P | Seminar | - | 4 | - | 4 | - | 2 | - | 2 | - | - | 100 | 100 | 200 |
| Total | | | 20 | 4 | - | 24 | 20 | 2 | - | 22 | 150 | 350 | 100 | 100 | 700 |

| Elective | Subject Name | | | |
|------------------------------------|----------------------------------|--|---|---|
| Elective-III (Discipline Specific) | 1. Advanced Separation Processes | 2. Advanced Process Dynamics & Control | 3. Advanced Chemical Reaction Engineering | 4. Environment, Health and Safety in Industries |

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
THIRD SEMESTER M.TECH (C.B.C.S.) (PETROCHEMICAL TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---------------------------------|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGOPEN 301T | Elective IV | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGFD 302T | Project Planning and Management | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 303P | *Project Seminar | - | 3 | - | 3 | - | 8 | - | 8 | - | - | 100 | 100 | 200 |
| Total | | | 8 | 3 | - | 11 | 8 | 8 | - | 16 | 60 | 140 | 100 | 100 | 400 |

| | | | | |
|--------------------|--------------------------------|-------------------|--|--|
| Elective-IV (Open) | 1. Advanced Petroleum Refining | 2. Nanotechnology | | |
|--------------------|--------------------------------|-------------------|--|--|

*For Work Load: 2 Hours/week/faculty

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FOURTH SEMESTER M.TECH (C.B.C.S.) (PETROCHEMICAL TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|----------|----------|---|---|-------|--------|----|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 401P | *Project | - | 6 | - | 6 | - | 16 | - | 16 | - | - | 200 | 200 | 400 |
| Total | | | - | 6 | - | 6 | - | 16 | - | 16 | - | - | 200 | 200 | 400 |

* For Work Load: 3 Hours/week/faculty

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FIRST SEMESTER M.TECH (C.B.C.S.) (OIL TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|--|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 101T/3 | Advanced Oil Chemistry and Oleochemicals | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGCHT 102T/3 | Advanced Quality Control Techniques | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 103T/3 | Technology of Expression, Extraction and Refining of Oil Bearing Materials | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 4. | PGCHT 104T/3 | Elective-I | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 5. | PGOPEN 105T | Elective-II | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 6. | PGCHT 106P/3 | Oil Technology Practical | - | 4 | - | 4 | - | 2 | - | 2 | - | - | 100 | 100 | 200 |
| Total | | | 20 | 4 | - | 24 | 20 | 2 | - | 22 | 150 | 350 | 100 | 100 | 700 |

| Elective | | | |
|----------------------------------|---|--|--|
| Elective-I (Discipline Specific) | 1. Technological Advancement in Oleochemicals | 2. Process Economics, Utilities and Byproducts of Oil Industry | |
| Elective-II (Open) | 1. Chemical Engineering Mathematics | 2. Modern Chemical Instrumentation | |

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
SECOND SEMESTER M.TECH (C.B.C.S.) (OIL TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 201T/3 | Technology of Soaps, Detergents & Surfactants | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGCHT 202T/3 | Technological Advancement of Cosmetics and Allied Products | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 203T/3 | Modification of Oil and Fat Products including Surface Coatings | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 4. | PGCHT 204T/3 | Elective III | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 5. | PGFD205T | Research Methodology | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 6. | PGCHT206P | Seminar | - | 4 | - | 4 | - | 2 | - | 2 | - | - | 100 | 100 | 200 |
| Total | | | 20 | 4 | - | 24 | 20 | 2 | - | 22 | 150 | 350 | 100 | 100 | 700 |

| Elective | Subject Name | | |
|------------------------------------|---|--------------------------|--|
| Elective-III (Discipline Specific) | 1. Environmental Aspects of Oil and Allied Industries | 2. Polymeric Surfactants | |

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
THIRD SEMESTER M.TECH (C.B.C.S.) (OIL TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---------------------------------|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGOPEN 301T | Elective IV | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGFD 302T | Project Planning and Management | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 303P | *Project Seminar | - | 3 | - | 3 | - | 8 | - | 8 | - | - | 100 | 100 | 200 |
| Total | | | 8 | 3 | - | 11 | 8 | 8 | - | 16 | 60 | 140 | 100 | 100 | 400 |

| | | | | |
|--------------------|--------------------------------|-------------------|--|--|
| Elective-IV (Open) | 1. Advanced Petroleum Refining | 2. Nanotechnology | | |
|--------------------|--------------------------------|-------------------|--|--|

*For Work Load: 2 Hours/week/faculty

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FOURTH SEMESTER M.TECH (C.B.C.S.) (OIL TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|----------|----------|---|---|-------|--------|----|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 401P | *Project | - | 6 | - | 6 | - | 16 | - | 16 | - | - | 200 | 200 | 400 |
| Total | | | - | 6 | - | 6 | - | 16 | - | 16 | - | - | 200 | 200 | 400 |

* For Work Load: 3 Hours/week/faculty

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FIRST SEMESTER M.TECH (C.B.C.S.) (PAINT TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 101T/4 | Chemistry of Film Forming Materials & Polymerization Techniques | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGCHT 102T/4 | Technology of Pigment Extenders and Additives | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 103T/4 | Principle and Formulation of Surface Coatings | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 4. | PGCHT 104T/4 | Elective-I | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 5. | PGOPEN 105T | Elective-II | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 6. | PGCHT 106P/4 | Paint Technology Practical | - | 4 | - | 4 | - | 2 | - | 2 | - | - | 100 | 100 | 200 |
| Total | | | 20 | 4 | - | 24 | 20 | 2 | - | 22 | 150 | 350 | 100 | 100 | 700 |

| Elective | | | |
|----------------------------------|-------------------------------------|---|-----------------------------|
| Elective-I (Discipline Specific) | 1. Automotive and Coil Coatings | 2. Technology of Cosmetics and Polishes | 3. Bio-Polymers in Coatings |
| Elective-II (Open) | 1. Chemical Engineering Mathematics | 2. Modern Chemical Instrumentation | |

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
SECOND SEMESTER M.TECH (C.B.C.S.) (PAINT TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 201T/4 | Manufacturing Methods, machinery & Planning | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGCHT 202T/4 | Processing, Application & Technology of Inks | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 203T/4 | Application, Evaluation of Surface Coating & Industrial Waste Treatment | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 4. | PGCHT 204T/4 | Elective III | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 5. | PGFD205T | Research Methodology | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 6. | PGCHT206P | Seminar | - | 4 | - | 4 | - | 2 | - | 2 | - | - | 100 | 100 | 200 |
| Total | | | 20 | 4 | - | 24 | 20 | 2 | - | 22 | 150 | 350 | 100 | 100 | 700 |

| Elective | Subject Name | | |
|------------------------------------|--|--|--|
| Elective-III (Discipline Specific) | 1. Functional Coatings (Super Hydrophobic and Self Healing Coatings) | 2. Chemistry and Technology of Nano-Pigments | |

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
THIRD SEMESTER M.TECH (C.B.C.S.) (PAINT TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|---------------------------------|----------|---|---|-------|--------|---|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGOPEN 301T | Elective IV | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 2. | PGFD 302T | Project Planning and Management | 4 | - | - | 4 | 4 | - | - | 4 | 30 | 70 | - | - | 100 |
| 3. | PGCHT 303P | *Project Seminar | - | 3 | - | 3 | - | 8 | - | 8 | - | - | 100 | 100 | 200 |
| Total | | | 8 | 3 | - | 11 | 8 | 8 | - | 16 | 60 | 140 | 100 | 100 | 400 |

| | | | | |
|--------------------|--------------------------------|-------------------|--|--|
| Elective-IV (Open) | 1. Advanced Petroleum Refining | 2. Nanotechnology | | |
|--------------------|--------------------------------|-------------------|--|--|

*For Work Load: 2 Hours/week/faculty

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FOURTH SEMESTER M.TECH (C.B.C.S.) (PAINT TECHNOLOGY)

| Sr. No. | Code (Board) Theo./Pract | Subject | Workload | | | | Credit | | | | MARKS | | | | Total Marks |
|---------|--------------------------|----------|----------|---|---|-------|--------|----|---|-------|-----------|------------|-----------|------------|-------------|
| | | | L | P | T | Total | L | P | T | Total | Theory | | Practical | | |
| | | | | | | | | | | | Sessional | University | Sessional | University | |
| 1. | PGCHT 401P | *Project | - | 6 | - | 6 | - | 16 | - | 16 | - | - | 200 | 200 | 400 |
| Total | | | - | 6 | - | 6 | - | 16 | - | 16 | - | - | 200 | 200 | 400 |

* For Work Load: 3 Hours/week/faculty

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Food Technology)
FIRST SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|--|------------------------------|---|--|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT1.03-4 | Special Technology I (Biochemistry and Analysis of Food Components) | Theory | PGCHT 101T/1 | Chemistry & Biochemistry of Food Components | Theory |
| 2. | CT 1.04-4 | Special Technology II (Molecular Biology) | Theory | PGCHT 104T/1 | Elective-I (Molecular Biology) | Theory |
| 3. | CT 1.05-4 | Special Technology III (Bioprocess Engineering) | Theory | PGCHT 103T/1 | Bioprocess Engineering | Theory |
| 4. | ---- | ---- | ---- | | | Theory |
| 5. | CT1.01 | Modern Chemical Instrumentation | Theory | PGOPEN 105T | Elective-II(Modern Chemical Instrumentation) | Theory |
| 6. | ---- | ---- | ---- | *PGCHT 106P/1 | Food Technology Practical | Practical |
| 7. | CE 1.02 | Science and Technology of Materials | Theory | ---- | ---- | ---- |

*Subject is covered in Second Semester for Old Pattern according to subject CT 2.06. They may be exempted.

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Food Technology)
SECOND SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|--|------------------------------|---|--|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT2.03-4 | Special Technology IV (Modern Trends in Food Science and Technology) | Theory | PGCHT 201T/1 | Advances in Food Science & Technology | Theory |
| 2. | CT2.04-4 | Special Technology V (Food Biotechnology) | Theory | PGCHT 202T/1 | Food Biotechnology | Theory |
| 3. | CT2.05-4 | Special Technology VI (Biotechnology Applications) | Theory | PGCHT 204T/1 | Elective III (Food Industry Waste Management) | Theory |
| 4. | ---- | ---- | ---- | | | Theory |
| 5. | ---- | ---- | ---- | PGFD205T | Research Methodology | Theory |
| 6. | ---- | ---- | ---- | PGCHT206P | Seminar | Practical |
| 7. | CT2.01 | Industrial Fermentations | Theory | ---- | ---- | ---- |
| 8. | CE2.02 | Environmental Engineering | Theory | ---- | ---- | ---- |
| 9. | CT 2.06 | Practical: Food Technology | Practical | ---- | ---- | ---- |

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Food Technology)

THIRD SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|--|------------------------------|---|---------------------------------|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | ---- | ---- | ---- | PGOPEN 301T | Elective IV | Theory |
| 2. | ---- | ---- | ---- | PGFD 302T | Project Planning and Management | Theory |
| 3. | ---- | ---- | ---- | PGCHT 303P | Project Seminar | Practical |
| 4. | CT3.01 | Seminar | Practical | ---- | ---- | ---- |
| 5. | CT3.02 | Training Report/Minor Project/Home Assignment | Practical | ---- | ---- | ---- |

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Food Technology)
FOURTH SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|-----------------------|------------------------------|---|----------------|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT 4.01 | Project and Viva-voce | Practical | PGCHT 401P | Project | Practical |

| Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Petrochemical Technology) | | | | | | |
|---|-----------------------------------|---|----------------------|---|--|----------------------|
| FIRST SEMESTER | | | | | | |
| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT1.03-3 | Special Technology-I (Science & Technology of Polymerisation) | Theory | PGCHT 101T/2 | Catalyst Science and Technology | Theory |
| 2. | CT1.04-3 | Special Technology II (Natural gas technology) | Theory | PGCHT 104T/2 | Elective I (Oil & Natural Gas Processing) | Theory |
| 3. | CT1.05-3 | Special Technology III (Lubricant waxes and Petroleum Special Product) | Theory | PGCHT 103T/2 | Petroleum Specialty Products | Theory |
| 4. | ---- | ---- | ---- | PGCHT 104T/2 | Elective-I | Theory |
| 5. | CT 1.01 | Modern Chemical Instrumentation | Theory | PGOPEN 105T | Elective-II (Modern Chemical Instrumentation) | Theory |
| 6. | ---- | ---- | ---- | *PGCHT 106P/2 | Process Simulation Laboratory | Practical |
| 7. | CE 1.02 | Science and Technology of Materials | Theory | ---- | ---- | ---- |

*Subject is covered in Second Semester for Old Pattern according to subject CT 2.06. They may be exempted.

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Petrochemical Technology)
SECOND SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|--|------------------------------|---|--|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT2.03-3 | Special Technology IV (Project Engineering of Petroleum and Petrochemical Plants) | Theory | PGCHT 201T/2 | Process Equipment and Piping Design | Theory |
| 2. | CT2.04-3 | Special Technology V (Petroleum Refinery Processing) | Theory | PGCHT 202T/2 | Multi Component Distillation | Theory |
| 3. | CT2.05-3 | Special Technology VI (Petrochemical Process Engineering) | Theory | PGCHT 203T/2 | Petrochemical Process Design | Theory |
| 4. | ---- | ---- | ---- | PGCHT 204T/2 | Elective III | Theory |
| 5. | ---- | ---- | ---- | PGFD205T | Research Methodology | Theory |
| 6. | | | | PGCHT206P | Seminar | Practical |
| 7. | CT2.01 | Biotechnology | Theory | ---- | ---- | ---- |
| 8. | CE2.02 | Environmental Engineering | Theory | ---- | ---- | ---- |
| 9. | CT 2.06 | Practical: Petrochemical Technology | Practical | ---- | ---- | ---- |

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Petrochemical Technology)

THIRD SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|---|------------------------------|---|---------------------------------|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | ---- | ---- | ---- | PGOPEN 301T | Elective IV | Theory |
| 2. | ---- | ---- | ---- | PGFD 302T | Project Planning and Management | Theory |
| 3. | ---- | ---- | ---- | PGCHT 303P | *Project Seminar | Practical |
| 4. | CT3.01 | Seminar | Practical | ---- | ---- | ---- |
| 5. | CT3.02 | Training Report /Minor Project/Home Assignment | Practical | ---- | ---- | ---- |

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Petrochemical Technology)
FOURTH SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|-----------------------|------------------------------|---|----------------|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT 4.01 | Project and Viva-voce | Practical | PGCHT 401P | Project | Practical |

| Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Oil Technology) | | | | | | |
|---|-----------------------------------|--|----------------------|---|--|----------------------|
| FIRST SEMESTER | | | | | | |
| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT1.03-1 | Special Technology I (Chemistry and Biochemistry of lipids and fatty materials) | Theory | PGCHT 101T/3 | Advanced Oil Chemistry and Oleochemicals | Theory |
| 2. | CT1.04-1 | Special Technology II (Analytical Techniques and Quality Control) | Theory | PGCHT 102T/3 | Advanced Quality Control Techniques | Theory |
| 3. | CT1.05-1 | Special Technology III (Technology of oil bearing materials and processing of oils) | Theory | PGCHT 103T/3 | Technology of Expression, Extraction and Refining of Oil Bearing Materials | Theory |
| 4. | ---- | ---- | ---- | PGCHT 104T/3 | Elective-I | Theory |
| 5. | CT 1.01 | Modern Chemical Instrumentation | Theory | PGOPEN 105T | Elective-II(Modern Chemical Instrumentation) | Theory |
| 6. | ---- | ---- | ---- | *PGCHT 106P/3 | Oil Technology Practical | Practical |
| 7. | CE 1.02 | Science and Technology of Materials | Theory | ---- | ---- | ---- |

*Subject is covered in Second Semester for Old Pattern according to subject CT 2.06. They may be exempted.

**Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Oil Technology)
SECOND SEMESTER**

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|---|------------------------------|---|--|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT2.03-1 | Special Technology IV (Technology of Soaps, detergents and Surfactants) | Theory | PGCHT 201T/3 | Technology of Soaps, Detergents & Surfactants | Theory |
| 2. | CT2.04-1 | Special Technology V (Technology of Cosmetics and allied products) | Theory | PGCHT 202T/3 | Technological Advancement of Cosmetics and Allied Products | Theory |
| 3. | CT2.05-1 | Special Technology VI (Technology of Miscellaneous Oil and Fat Products, including Surface Coatings) | Theory | PGCHT 203T/3 | Modification of Oil and Fat Products including Surface Coatings | Theory |
| 4. | ---- | ---- | ---- | PGCHT 204T/3 | Elective III | Theory |
| 5. | ---- | ---- | ---- | PGFD205T | Research Methodology | Theory |
| 6. | ---- | ---- | ---- | PGCHT206P | Seminar | Practical |
| 7. | CT2.01 | Biotechnology | Theory | ---- | ---- | ---- |
| 8. | CE2.02 | Environmental Engineering | Theory | ---- | ---- | ---- |
| 9. | CT 2.06 | Oil Technology : Practical | Practical | ---- | ---- | ---- |

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Oil Technology)

THIRD SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|---|------------------------------|---|---------------------------------|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | ---- | ---- | ---- | PGOPEN 301T | Elective IV | Theory |
| 2. | ---- | ---- | ---- | PGFD 302T | Project Planning and Management | Theory |
| 3. | ---- | ---- | ---- | PGCHT 303P | *Project Seminar | Practical |
| 4. | CT3.01 | Seminar | Practical | ---- | ---- | ---- |
| 5. | CT3.02 | Training Report /Minor Project/Home Assignment | Practical | ---- | ---- | ---- |

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Oil Technology)

FOURTH SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|-----------------------|------------------------------|---|----------------|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT 4.01 | Project and Viva-voce | Practical | PGCHT 401P | Project | Practical |

| Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Paint Technology) | | | | | | |
|---|-----------------------------------|---|----------------------|---|---|----------------------|
| FIRST SEMESTER | | | | | | |
| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT1.03-2 | Special Technology I (Chemistry of film forming materials and polymerization techniques) | Theory | PGCHT 101T/4 | Chemistry of Film Forming Materials & Polymerization Techniques | Theory |
| 2. | CT1.04-2 | Special Technology II (Technology of pigments extenders and additives) | Theory | PGCHT 102T/4 | Technology of Pigment Extenders and Additives | Theory |
| 3. | CT1.05-2 | Special Technology III (Principles of formulations of surface coatings) | Theory | PGCHT 103T/4 | Principle and Formulation of Surface Coatings | Theory |
| 4. | ---- | ---- | ---- | PGCHT 104T/4 | Elective-I | Theory |
| 5. | CE 1.01 | Modern Chemical Instrumentation | Theory | PGOPEN 105T | Elective-II | Theory |
| 6. | ---- | ---- | ---- | *PGCHT 106P/4 | Paint Technology Practical | Practical |
| 7. | CE 1.02 | Science and Technology of Materials | Theory | ---- | ---- | ---- |

*Subject is covered in Second Semester for Old Pattern according to subject CT 2.06. They may be exempted.

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Paint Technology)
SECOND SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|-----------------------------------|---|----------------------|---|---|----------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT2.03-2 | Special Technology IV (Manufacturing methods, machinery and planning) | Theory | PGCHT 201T/4 | Manufacturing Methods, machinery & Planning | Theory |
| 2. | CT2.04-2 | Special Technology - V (Processing applications and Technology of inks) | Theory | PGCHT 202T/4 | Processing, Application & Technology of Inks | Theory |
| 3. | CT2.05-2 | Special Technology - VI (Application, evaluation of surface coatings and industrial waste treatment) | Theory | PGCHT 203T/4 | Application, Evaluation of Surface Coating & Industrial Waste Treatment | Theory |
| 4. | ---- | ---- | ---- | PGCHT 204T/4 | Elective III | Theory |
| 5. | ---- | ---- | ---- | PGFD205T | Research Methodology | Theory |
| 6. | CT2.01 | Biotechnology | Theory | PGCHT206P | Seminar | Practical |
| 7. | CE2.02 | Environmental Engineering | Theory | ---- | ---- | ---- |
| 8. | CT 2.06 | Practical : Paint Technology | Practical | ---- | ---- | ---- |

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Paint Technology)

THIRD SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|---|------------------------------|---|---------------------------------|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | ---- | ---- | ---- | PGOPEN 301T | Elective IV | Theory |
| 2. | ---- | ---- | ---- | PGFD 302T | Project Planning and Management | Theory |
| 3. | ---- | ---- | ---- | PGCHT 303P | *Project Seminar | Practical |
| 4. | CT3.01 | Seminar | Practical | ---- | ---- | ---- |
| 5. | CT3.02 | Training Report /Minor Project/Home Assignment | Practical | ---- | ---- | ---- |

Scheme of Absorption for Old Pattern to CBCS Pattern of M. Tech. (Paint Technology)

FOURTH SEMESTER

| As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Pattern) | | | | As Per Rashtrasant Tukadoji Maharaj Nagpur University Choice Based Credit Scheme | | |
|--|--|-----------------------|------------------------------|---|----------------|------------------------------|
| Sr. No. | Sub. Code Theory/ Practical | Subject | Theory/ Practical | Sub. Code Theory/ Practical | Subject | Theory/ Practical |
| 1. | CT 4.01 | Project and Viva-voce | Practical | PGCHT 401P | Project | Practical |

SYLLABUS FOR FIRST SEMESTER M. TECH. (C.B.C.S.)

PGCHT101T/1

Credit: 4

Chemistry and Biochemistry of Food Components

Unit 1: Chemistry of carbohydrates, fats and proteins. Colloidal properties of foods. Browning Reaction

Unit 2: Structure and Composition of Plant tissues. Physiology of plant tissues. Post harvest biochemical changes of fruits & vegetables. Transpiration and respiration of plant tissues. Changes during ripening of climacteric and non climacteric fruits. Controlled Atmospheric and Modified Atmospheric storage. Post harvest management of fruits & vegetables. Natural plant pigments. Effect of processing on plant pigments.

Unit 3: Structure and composition of animal muscle tissues. Biochemical changes in animal muscle. Conversion of animal muscle tissue into meat. Rigor mortice. Post mortem biochemical changes in animal muscle. Preservation techniques. Effect of cooking & processing. Tenderness in meat.

Unit 4: Natural and developed toxins in foods of plant and animal origin. Types of food additives and their role in food products. Non nutritive sweeteners. Intentional and non intentional food additives,

Unit 5: Assessment of food safety. Modern methods of food analysis such as spectrophotometry, chromatography, electrophoresis, Immuno assay techniques, Biosensors, etc.

PGCHT 101T/2

Credit: 4

Catalyst Science and Technology

Unit 1: Heterogeneous Catalytic Processes, Types of Heterogeneous Reactions, Absorption, Adsorption Isotherms, Rates of Absorption, Physisorption and Chemisorptions.

Unit 2: Solid Catalysis, Types of Catalysts, Catalyst Formulations and Preparation Methods, Catalysts Characterization Methods: Surface Area and Pore Volume Determinations, XRD, Various Spectroscopic Techniques, Temperature Programmed Reduction & Oxidation, Electron Microscopy.

Unit 3: Testing of Catalysts, Various Types of Reactors, Activity and Selectivity Studies, Effect of External Transport Processes on observed rate of reactions.

Unit 4: Effect of Internal Transport Processes: Reactions and Diffusion in Porous Catalysts, Mechanism of Catalytic Reactions, Rates of Adsorption, Desorption, Surface Reactions, Rate Determining Steps.

Unit 5: Kinetic Modelling and Parameter Estimations, Model Discriminations, Catalysts Promoters, Inhibitors, Catalyst Deactivations, Kinetics of Catalyst Deactivations.

Unit 6: Industrial Processes involving Heterogeneous Solid Catalysts, New Development in Solid Catalysis, Monolith Catalysts, Nano-catalysts, Fuel Cell Catalysts, Environmental Catalysts, In situ Characterization, Design of Catalysts; Simulation Techniques.

References:

1. G. Ertl, H. Knozinger and J. Weitkamp, "Handbook of Heterogeneous Catalysis" Vol 1-5, Wiley - VCH.
2. B. Viswanathan, S. Sivasanker, A.V. Ramaswamy, "Catalysis : Principles & Applications" CRC Press.
3. J. M. Smith, "Chemical Engineering Kinetics" McGraw-Hill Book Company.
4. J. M. Thomas and W. J. Thomas, "Principles and Practice of Heterogeneous Catalysis", Wiley-VCH.
5. H. S. Fogler, "Elements of Chemical reaction engineering" Prentice – Hall of India.
6. J.J. Carberry, "Chemical and catalytic reaction Engineering", Dover Publications.
7. C. H. Bartholomew and R. J. Farrauto "Fundamentals of Industrial catalytic Processes", Wiley-VCH.

PGCHT 101T/3

Credit: 4

ADVANCED OIL CHEMISTRY AND OLEO CHEMICALS

Unit-1 Natural sources of fats and oils, their geographic distribution. Fatty acid and triglyceride composition of fats, its types, nomenclature, structure. Theories of tri glyceride composition. Classification of fat, various types of classification and their basis, constituent of fats and fatty acids

Unit-2 Mechanism related to chemical and biochemical reactions of fats and fatty acids; Hydrolysis, Acidolysis, Saponification, Esterification, Inter-esterification, Trans-esterification, Isomerisation, polymerization, Hydrogenation, Dehydration, Pyrolysis and Oxidation. Polymorphism of fats and fatty acids. Chemical synthesis of fatty acids and their derivatives

Unit-3 Elementary chemical analytical constants of oils and fats like Acid value, Iodine value, Acetyl Value, Hydroxyl value, Ester value, HBr Value, Peroxide value, RM, Krischner and Polenske values. Elementary physical analytical constants of oils and fats like Refractive index, specific gravity, titer, smoke point, flash point, Cloud Point.

Unit-4 Non glyceride components of oils & fats phospholipids, glycol lipids, neutral lipids, sterols, etc. Toxic constituents & Detoxification Biosynthesis of oils & fatty acids. Role of fat in human metabolism. Nutritional functions of fats and oils

Unit-5 Fatty acids, distillation, crystallization, Fractionation, High purity fatty acid products blend distillation.

Reference Book

1. The Chemical Constitution of Natural Fats, Hilditch T.P., Chapman and Hall Ltd., London.
2. Fatty acids: Their chemistry, properties, production, and uses, Markley K.S., Interscience Publishers, New York

3. An introduction to the chemistry and biochemistry of fatty acids and their triglycerides, Gunstone F.D.. Chapman & Hall Ltd., London.
4. Bailey's Industrial Oil and Fat Products, 6th Edition, Wiley-Interscience Publication, New York .
5. The Analysis of Fats and Oils, Mehlenbacher, V. C., The Garrard Press, Champaign, Illinois.
6. AOCS Official and Tentative Methods for Analysis of Oils and fats, Vol. 1 and 2., Third Edition, AOCS, Champaign IL,USA.
7. Modern Technology Of Oils, Fats & Its Derivatives,National Institute of Industrial Research, New Delhi.

PGCHT 101T/4

Credit: 4

Chemistry of film forming materials and polymerization techniques

Unit 1: Natural Resins and Chemistry of drying oils

Natural resins, Composition of major natural resins: Rosin, Copals, Shellac, Damar, etc. used in coatings, Recovery and purification, Modification of natural resins. Applications of natural resins in coatings.

Drying oils and their modifications Modifications of drying and semidrying oils for surface coatings. Synthetic drying oils

Unit 2: Synthetic Resins-I Chemistry and Technology of synthetic resins: Alkyd resins, Polyester, Amino resins, Phenolic resins and Polyamide resins. Recent trends in the alkyd, polyester, amino, phenolic and polyamide resins technology.

Unit 3: Synthetic Resins-II

Chemistry and Technology of synthetic resins: Epoxy resins, polyurethane resins, silicone resins, Recent trends in the epoxy resin, polyurethane resins. Modification of epoxy resins. Inorganic binders.

Unit 4: Synthetic Resins-III Techniques of polymerization, manufacture of film forming materials such as acrylic and vinyl resins for use in surface coating. Cellulose and rubber derivatives for coatings.

Unit:5: Development and evaluations of binders:Recent developments in the formulation of vehicles, Evaluation of film forming materials for surface coating.

PGCHT102T/1

Credit: 4

Food product Development and Packaging

Unit 1: Concept of new product development, principles of product development, product development strategic orientation, process tools for NPD, product planning, PD process flow, protecting new product, new product failure and considerations during NPD. Acceptance sampling: operational characteristics, risks, attribute sampling plans, administration of attribute sampling plans, sampling error; Physical, chemical and rheological properties of food; Principles of analysis of various food constituents and subsequent changes on packaging;

Unit 2: Sensory attributes of foods: mechanisms of sensation and perception of colour, taste, odour, and flavour; importance and use of sensory evaluation methods; facilities required for sensory evaluation; selection of trained panelists: type of panelists suitable for different tasks and methods; conditions for sensory analysis: room, serving and preparation of samples; application of consumer tests;

Unit 3: affective and analytical methods: discrimination methods, preference and ranking; rating with use of scales, magnitude determination, sensory profiling, flavour profile; descriptive analysis: Quantitative

Descriptive Analysis and Spectrum techniques; texture profile; control of factors affecting accuracy and precision of sensory data; analysis of sensory data; statistical testing; correlating instrumental and sensory measurements.

Unit 4: Packaging as a method for conservation of foods Packaging materials and their physico-chemical characteristics Evaluation of quality of packaging materials; Package design; Test procedures for packages; Cushioning materials; Selection of packaging materials

Unit 5: package design for food products; Prepackaging. Packaging materials for newer techniques like radiation processing, microwave and radiowave processing, high pressure processing, modified atmosphere and thermal processing as retortable pouches; Biodegradable packaging, Edible packaging, smart packaging.

Reference Books:

- A. V. Sathe, *A First Course in Food Analysis*, New Age International Pvt. Ltd. 1999
S. S. Nielsen, *Food Analysis, 3rd ed.*, Kluwer Academic Publishers, 2003
S. S. Nielsen, *Food Analysis Laboratory Manual*, Kluwer Academic Publishers, 2003
R.Wood, L.Foster, A.Damant and P.Key, *Analytical Methods for Food Additives*, Woodhead Publishing, 2004
Y. Pomeranz and C.E.Meloan, *Food Analysis: Theory and Practice, 3rd ed.*, Chapman & Hall, 1994
AOAC, *Official Methods of Analysis and AOAC International*, 2005
R.E.Wrolstad, T.E. Acree, E.A.Decker, M.H.Penner and D.S.Reid, *Handbook of Food Analytical Chemistry*, John Wiley & Sons, 2004
Modern food packaging, Indian Institute of Packaging, 1998
Profile on food packaging/C.F.T.R.I and Indian Institute of packaging, 1995.
Food packaging and preservation by M.Malthlouthi, 1994
Food and Packaging Interactions by Risch.S.H. 1991
Handbook of Food Packaging by F.A. Paine and H.Y. Paine 1983
Food Packaging Technology (Vol.1 & 2) by G. Bureau and J.L.Multon, 1996

PGCHT 102T/2

Credit: 4

Petroleum Refinery Engineering

Unit 1: History and development of Refining, Composition of Petroleum, Refinery products and Test methods, Evaluation of Oil stocks, Physical properties of Petroleum Oil.

Unit 2: Introduction to Processing, Refinery and Distillation Process, Auxillary processes and operations, Refinery metals and Corrosion

Unit 3: Vaporization and Condensation, Fractionation and Towers;

Unit 4: Heat transfer and Exchangers, Tube-still Heaters.

Unit 5: Thermal Cracking and Decomposition Processes, Rebuilding Hydrocarbons.

Unit 6: Catalytic Cracking and Reforming, Natural and Refinery gases

References

1. Nelson, W.L "Petroleum Refinery Engineering" McGraw Hill Publishing Company Limited.
2. Hobson, G.D. – Modern petroleum Refining Technology, 4th Edition, Institute of Petroleum U.K.
3. J.H. Gary And G.E. Handwerk " Petroleum Refinery Technologies And Economics ".

PGCHT 102T/3

Credit: 4

ADVANCED QUALITY CONTROL TECHNIQUES

Unit -1: Importance of Quality control, Techniques of separation of glyceride and fatty acids: Liquid – liquid extraction; fractional distillation; low temperature crystallization. Testing of DOC and Oil beyond conventional testing for export. Detection of adulteration in oils and fats

Unit -2

Chromatography: History, theoretical developments and various techniques e.g., thin layer chromatography,, gas-liquid chromatography, HPLC and Super critical Chromatography; their principles, practices and applications to the analysis of oils and allied products. Application of chromatographic techniques in the quality control and quality assurance of oils, fats and products

Unit –3

Spectral methods of application; Ultra-violet, visible, infrared infra red spectroscopy techniques: principles, practices and application to the analysis of oils and allied products. Nuclear magnetic resonance spectroscopy: principle, analysis of spectra and quantitative applications.

Unit –4

Special quality control methods like iron, sulphur and phosphatide content of crude and refined vegetable oils; wax content of vegetable oils; amino acid analysis by chemical and instrumental methods.

Unit –5

Lipase hydrolysis, Dilatometry measurements and their significance, Determination of color and viscosity of oils and fats, solid fat index of oils and fats. Essential Fatty acids and Trans fats.

Reference Books:

1. Fatty acids; Their chemistry, properties, production and uses Part – III Edited by K.S. Markley
2. Principles of Instrumentation analysis, Edition- III (1985) Edited by Douglas A. Skog
3. Sharma Y.R. Vig O.P., "Elementary Organic spectroscopy" S. Chand & Company Ltd, 1994, P. No. 63-127, 133-199.
4. Silverstein R. M., Webster F.X., "Spectroscopic identification of organic compound", 6th edition to John Willey & sons, Inc, New York, 1998, P. No. 71-143, 217-250.
5. Puri B.R, Sharma I.R, "Principles of physical chemistry", S. Chand & co. New Delhi, 1997.

PGCHT 102T/4

Credit: 4

Technology of Pigments, Extenders and Additives

Unit 1: General properties of pigments, Classification of pigments, extender, lakes and toners. General methods of manufacture of pigments. General properties of pigments and extenders. Metal pigments and metallic stearates: Composition, manufacture, properties and applications. Extenders: Composition and properties, occurrence and manufacture of extenders.

Unit 2: White and black Pigments

White pigments, composition and comparison of properties, occurrence and manufacture of white pigments. Black pigments, comparison of various black pigments and their composition.

Unit 3: Coloured Pigments:

Coloured inorganic pigments, comparison of properties and their composition, methods of manufacture of red, organic, yellow, green and blue pigments.

Unit 4: Organic Pigments:

Organic pigments, methods of manufacture, important class and properties of organic pigments, production of lakes and toners.

Unit 5: Specialty pigments, additives and solvents

Introduction of important pigments and their evaluation, special purpose pigments.

Classification, properties of various types of driers, manufacture of driers. Additives for surface coatings.

Solvents for surface-coatings, classification, selection and evaluation,

PGCHT 103T/1

Credit: 4

Bioprocess Engineering

Unit 1: Thermodynamics of biosystem. Material and energy balances. Microbial growth dynamics. Kinetics of substrate utilization, biomass production and product formation in cell cultures.

Unit 2: Design, Preparation and sterilization of fermentation media and bioreactor. Air sterilization and asepsis.

Unit 3: Bioreactor configuration. Practical considerations for bioreactor construction. Monitoring and control of Bioreactors. Ideal reactor operation.

Unit 4: Rheological properties of fermentation broths, factors affecting broth viscosity. Mixing power requirement for mixing, scale up of mixing systems, improving in mixing in fermenters. Design equation for heat transfer systems in fermenter. Development and applications of Biosensors

Unit 5: Role of diffusion in bioprocessing. Mass transfer and microbial respiration. Oxygen uptake in cell cultures. Oxygen transfer in fermenters. Measuring dissolved oxygen concentrations. Mass transfer correlations. Measurement of $K_L a$. Oxygen transfer in Large Vessels.

Reference Books:

1. J. E. Bailey, D F Ollis, Biochemical Engineering Fundamentals, McGraw- Hill 1986
2. P. M. Doran, Bioprocess Engineering Principles, Academic Press
3. J. M. Lee, Biochemical Engineering , Prentice Hall, Englewood Cliffs, New Jersey
4. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering- Basic Concept, Second edition, Prentice Hall.

PGCHT 103T/2

Credit: 4

Petrochemical Process Design

Unit-1: Complex reaction, consecutive reaction, parallel reaction and parallel and consecutive reactions, acetylene production from hydrocarbons, kinetics and thermodynamics, different process details, parallel-consecutive reaction in a batch and flow reaction(TFR and CSTR), kinetics, derivation, industrial processes of chlorination of hydrocarbon, amines and glycols, effect of reactant ratio on distribution of products in different types of reactors.

Unit-2: Pyrolysis of hydrocarbon for production of olefins, thermodynamics and kinetics, thermal cracking mechanism, role of self inhibition, surface reactions and isomerisation of radicals in mechanism product distribution in cracking processes, condition of operation of pyrolysis reactors, concept of equilibrium approach and its influence on conversion, selectivity, steam dilution and yield of products desirable condition for ethylene productions use of kinetics models in the design, kinetics of petroleum fractions for olefin production. Effect of various process design parameters like tube diameter, hydrocarbon to steam ratio, pressure drop etc on conversion and yields.

Unit-3: Exothermic catalytic reactions – some industrially important reactions like production of phthalic anhydride, ethylene oxide, vinyl chloride and cyclohexane. Reactor operating condition. Kinetics of phthalic anhydride, simple and complex models operating features of different reactors used, factors influencing the choice of conditions of fluidized beds, mathematical derivations involved , analysis of naphthalene oxidation in fixed beds, one dimensional and two dimensional models, their derivation.

Unit-4: Ethylene oxide manufacture, its status among ethylene derivatives, direct oxidation process, chemistry and mechanism, side reaction, process design aspects such as thermal factors, exothermicity on selectivity, ethylene conversion, feed stock preparation, inhibitors, plant safety, catalyst details manufacturing process details, reversible exothermic reactions, important features , manufacture of ammonia.

Unit -5: Production of styrene from ethylene benzene, theoretical considerations, variables effecting styrene yields, such as pressure, temperature, steam to ethyl benzene ratio, catalyst particle size, purity of feed catalyst to ethyl benzene ratio, different reactor systems employed in styrene production, practical considerations, process details and styrene purification.

Unit-6: Mass transfer influence on kinetics of Ziegler-Natta ethylene polymerization, types of polymerization, fundamentals of polymerization, design aspects of polymer reactors. Mass transfer influence on hydroformylation reaction, reactor design process details, kinetic models, effect of olefin structure on reactivity, engineering problem in reactor design with a flow scheme.

References:

1. Chemical Engineering process analysis, A.M. Mearns
2. Chemistry of Catalytic processes, B.C. Gats, J.R. Katzer and G.C.A. Schuit
3. Chemical reactor design and process plants, vol 1 and 2, H.A. Rase.

4. Equipment Design Handbook for Refineries and Chemical Plants, F.L. Evans.
5. Applied Process Design For Chemical and Petrochemical Plants Vol I, II, and III, E.E. Ludwig.

PGCHT 103T/3

Credit: 4

TECHNOLOGY OF EXPRESSION, EXTRACTION AND REFINING OF OIL BEARING MATERIALS

Unit-1 Domestic and world production of oil seeds and oils. Processing of oil-bearing materials: Storage of raw materials, handling, sampling, pretreatments prior to storage, methods of cleaning, and milling, crushing, cooking and mechanical expression of oil. Newer Methods in of oil extraction. Rendering of animal fats. Utilization of oil cakes.

Unit-2 Plant and Machinery employed for expression of oils viz. Mechanical expression of oil in Ghanis, hydraulic presses, screw presses, low pressure and high pressure expellers' expander- extruder system

Unit-3 Pre-treatments of oil bearing materials prior to solvent extraction: cleaning, size reduction, pre-pressing, flaking, extrusion, pelletization, stabilization (for rice bran), dehulling etc. Plants & Processes and the machinery and equipments used.

Unit-4 Solvent extraction: Theory, solvents and their availability, selection of solvents, advantages and limitations, properties of different solvents. Solvent extraction techniques: Batch and continuous plants and processes employed for solvent extraction of low and high oil bearing materials. Recent trends in solvent extraction.

Unit-5 Refining of fats: Various physical and chemical methods of refining such as degumming, Neutralization, bleaching & deodorization. Plants and equipment used in batch and continuous refining. Quality control in processing

Reference Books:

1. Refining of Oils& Fats, Anderson, A. J. C, The MacMillan Co., New York.
2. Fats and Oils, D O'Brien, Third Edition, CRC Press,London
3. Bailey's Industrial Oil and Fat Products, 6 Volumes, Wiley-Interscience Publication,New York 4. Confectionary fats Handbook, Timms, R. E. The Oily Press Lipid Library, UK
5. Practical Short Course on Processing and Products of Vegetable Oil / Biodiesel ,College Station, Texas, Held on October 18-22, 2009
6. Vegetable Oils in Food Technology (Chemistry and Technology of Oils and Fats), Frank Gunstone, Wiley Blackwell; USA
7. Edible Oils and Fats--A Global Overview of Technological Developments, Guinness Centre, Taylors Lane,, Ireland.

PGCHT 103T/4

Credit: 4

Principles and Formulations of Surface Coatings

Unit 1: Concept of Formulations

Principles of formulations of surface coating with special reference to paints, varnishes, lacquer.

Unit 2: Protective and Decorative coatings

Selection of raw materials for its specific applications, viz. Protective, decorative and their types. Architectural finishes,.

Unit 3: Industrial and Specialty Finishes

Industrial and Specialty coatings like, heat resistant, marine, traffic & fluorescent. Recent trends in industrial and specialty coatings.

Unit 4: Rheology of paints

Rheology of paint systems and its importance in coatings. Film formation, film structure and its correlation to formulation. PVC and CPVC, Thioxtrophy.

Unit 5: Powder Coatings

Solvents less and powder coatings. Binder for powder coatings and their classification. Selection of pigments, extenders and additives. Manufacture of coating powders: Methods and equipments. Application techniques in powder coatings.

Recent developments in powder coatings

PGCHT 104T/1

Credit: 4

ELECTIVE - I (Discipline Specific BCHE)

1. Advances in Food Engineering

Unit 1: Application of Transport Phenomena for food systems. Flow behaviour of non Newtonian fluids. Unsteady state Heat Transfer with phase change. Heat transfer during freezing and thawing. Rheology of dough with reference to wheat and bakery products.

Unit 2: Design of autoclave, Pasteurizer, Continuous Sterilizer, Steam Jacketed Pan and

Vacuum Concentrator. Materials used for food processing equipment and corrosion control.

Unit 3: Design of Basket Press, Screw type Juice Extractor, Solid Mixer, Kneader; Oil Expeller, filters and extruder.

Unit 4: Design of Tray Drier, Drum Drier, Spray Drier, Fluidized Bed Drier and Rotary Roaster, solar dryers.

Unit 5: Design of Homogenizer, Pulping Machine, Plate Type Freezer and Freeze Drier.

Reference Books:

Food Engineering Operations by Brennan J.G, 1976

Fundamentals of food process engineering by Romeo Toledo, 1999

Engineering Properties of Foods by Rao MA and Rizvi SSH, 1986

Elements of Food Engineering by Watson EL and Harper JC, 1989

Food Process Engineering by Heldman DR and Singh RP, 1984

Food Engg. Fundamentals by J. Clair Batty, 1983

Chemical Engineer's Handbook; Perry, Chilton & Green; MGH.

Fundamentals of Food Process Engineering, 2nd ed; Toledo Romeo T; CBS Publishers.

Preservation of Fruits & Vegetables; Lal G, Sidhapa GS & Tandon GL; ICAR.

Introduction to Chemical Equipment Design – Mechanical Aspects; Bhattacharyya BC; CBS Publishers.

Process Equipment Design; Hesse HC & Rushton JH; Van Nostrand, East West Press Selection of Material and Fabrication for Chemical Process Equipment; Bhattacharyya BC; Chemical engineering Education Development Centre, IIT Madras.

Process Equipment Design; Brownell LE & Young EH; John Wiley and Sons, Inc.

Computer Aided Design of Chemical Process Equipment; Bhattacharyya BC & Narayanan CM; New Central Book Agency.

Mechanical Design and Fabrication of Process Equipment; Bhattacharyya BC; sKhanna Publishers.

PGCHT 104T/1

Credit: 4

ELECTIVE - I (Discipline Specific BCHT)

2. Molecular Biology

Unit 1: Chemical structure and base composition of nucleic acid. Double helical structures, triple helical structures. Properties of DNA. DNA denaturation and renaturation. DNA replication and repair mechanisms in eukaryots, bacteria and phages.

Unit 2: Transcription: RNA polymerases in prokaryots and eukaryots. Process of transcription. Concept of promoters and promoters types. Post transcriptional processing of RNA, Translation: Genetic Code. Post translational modifications. Protein targeting. Non ribosomal polypeptide synthesis.

Unit 3: Regulation of gene expression: Constitutive and inducible enzymes Gene regulation, operon concept (Lac operon and trp operon). Induction of genes under stress conditions in plants. Differential processing of mRNA.

Unit 4: Mutation: Spontaneous and induced mutations. Insertion, deletion, point, frame shift and suppressor mutation. Chemical & physical mutagens. Selection and isolation of mutants.

Unit 5: Genetic Engineering: Recombinant DNA technology. Isolation and amplification of gene cloning vectors. Application of recombinant DNA technology.

PGCHT 104T/1

Credit: 4

ELECTIVE - I (Discipline Specific BCHT)

3. Advances in Nutrition

Unit 1:Recent advances in metabolism and nutritional aspects of foods; Nutritional requirements of special target groups such as aged, infants, pregnant & lactating mothers, etc.

Unit 2: Therapeutic nutrition & formulation of special dietary foods; Relation of food and diseases; Nutrition related diseases. Assessment of nutritional status & RDA; Effect of processing on nutrients;

Unit 3: Functional foods and nutraceuticals for lifestyle disorders such as cardiovascular diseases, obesity, diabetics, etc. Glycemic Index and Glycemic load of composite foods.

Unit 4: Protective foods: Role of food ingredients in aging, cancer and immunomodulation. Food components and nutrients affecting immune systems, phytosterols, polyphenols, flavonoids and antioxidants.

Unit 5:Functional aspects of dietary fibre, amino acids & peptides, probiotic foods, antioxidants, vitamins, fatty acids etc. Regulatory aspects for functional foods and nutraceuticals.

Reference Books:

Advances in food and nutrition research by Steve L. Taylor
Human nutrition by Alfin-Slater, 1979,
Human nutrition by Burton, BT, 1976,
Food, Nutrition and Diet Therapy by Krause and Mahan 1996,
Modern Nutrition in Health & Disease by Young & Shils.

ELECTIVE I (Discipline Specific BCHT)**1. Oil & Natural Gas Processing****Unit 1: Introduction**

Brief history of natural gas industry, characteristics of various utility and industrial gases, sources of natural gas, occurrence, composition, chemical properties and characteristics of natural gas

Unit 2: Phase Behaviour

Phase behavior of natural gas, pressure-volume-temperature diagram for pure hydrocarbons. Phase rule, solubility of gases in liquids, binary mixtures.

Unit 3: Properties

Properties of natural gases and volatile hydrocarbon liquids, diffusion coefficient, compressibility factors, density of gases and liquids, surface tension, thermodynamic properties, heating value, flammability limits, critical properties, viscosity and thermal conductivity.

Unit 4: Gas Hydrates

Water-hydrocarbon system, general phase relations for water-hydrocarbon system, measurement of water contents of natural gas, gas hydrates, conditions of formation, prediction of hydrate formation condition, prevention of hydrate formation.

Unit 5: Gas Flow Measurement

Gas flow measurement, flow and compressor calculations, flow equation, pipeline flow calculations, calculations of work required to compress natural gas.

Unit 6: Gas Processing

Low temperatures processing of natural gas, natural gas liquefaction, dehydration and sweetening of natural gas, methods of dehydration and sweetening.

References:

1. Donald L.Katz and Robert L.Lee, Natural Gas Engineering, McGraw – Hill Publishing Company, NY.
2. Speight, J.G Fuel Science and Technology Handbook, Marcel Decker Inc.
3. Dring, M.M – The Natural Gas Industry – A review of World Resources and Industrial Applications, Butterworth, London.
4. Lom. W.L and A.F. Williams, Substitute Natural Gas, Kalstod Willey, New York.
5. Dermott, M.C. Liquefied Natural Gas Technology, NeysosPark Ridge, N.J.
6. M.J. Economides A.Daniel “Petroleum Production Systems”, Prentice Hall Petroleum Engineering series.
7. Michael J.Economides, A.Daniel Hill and Christine Ehlig – Economides, Petroleum Production Systems, PTR Prantice Hall, NJ.
8. Guide to Natural Gas Utilization Technologies, Fairmount Press Inc.

ELECTIVE I (Discipline Specific BCHT)**2. Modeling & Simulation in Chemical Engineering**

- Unit 1:** Introduction to process modeling, Applications of models, classification of models, Principles of Formulation, fundamental laws, general modeling procedure, industrial usage of process modelling and simulation; Macroscopic and microscopic mass, energy and momentum balances
- Unit 2:** Parameter estimation techniques in theoretical as well as numerical models, population balance, stochastic, and empirical models
- Unit 3:** Modeling of various mass and heat transfer equipment: distillation, absorption, extraction columns; evaporators; furnaces; heat exchangers; flash vessels etc.
- Unit 4:** Modeling of Chemical Reactors: single phase and multiphase reactors
- Unit 5:** Numerical Methods for chemical engineering applications. Introduction and use of different softwares for modeling and simulation

Recommended Books:

1. W. L. Luyben, Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill, 1990.
2. S.C. Chapra, R.P. Canale, Numerical Methods for Engineers, 6th Edition, Tata-McGraw Hill Publications, 2012.
3. R.E.G. Franks, Modeling and Simulation in Chemical Engineering, Wiley-Interscience, NY, 1972.
4. J. Ingam, I. J. Dunn, Chemical Engineering Dynamic Modeling with PC simulation, VCH Publishers, 2008.
5. D. Himmelblau, K.B. Bischoff, Process Analysis and Simulation, John Wiley & Sons, 1968.

ELECTIVE I (Discipline Specific BCHT)**3. Advanced Transport Phenomena**

- Unit 1:** Review of mathematics: Scalar, Vectors, Tensors, divergence, relation between rectangular coordinates and cylindrical coordinates, relation between rectangular coordinates and spherical coordinates, partial derivative, substantial derivative, total derivative, line integral, surface integral, integral theorems.
- Unit 2:** Equations of continuity, equation of motion, the equation of mechanical energy, application of Navier-Stokes equation to solve problems, the equations of change for incompressible non-Newtonian fluids.
- Unit 3:** Developing equations for obtaining velocity & shear stress distribution for flow of Newtonian, Bingham plastic & power law fluids in spheres etc. from Ist principle, Introduction to 2 dimensional & turbulent momentum transfers
- Unit 4:** Equations of energy, the energy equation in curvilinear coordinates, use of equations of change to set up steady state heat transfer for problems.
- Unit 5:** Unsteady state heat conduction expression for rectangular, spherical and cylindrical coordinate system from Ist principles, Numerical methods for 2 dimensional steady state conduction and Schmidt method for unsteady state heat conduction with / without surface resistance for obtaining temperature profiles

Recommended Books:

1. R.B. Bird, W. E. Stewart and E. N. Light foot Transport Phenomena Wiley international Edition, New York 2002.
2. James R. Welty, Charles E. Wicks and Robert E. Wilson, Fundamentals of momentum, heat and mass transfer, John Wiley & sons, Inc, New York, 2008.

ELECTIVE I (Discipline Specific BCHT)**4. Advanced Thermodynamics**

Unit 1: Quantum Considerations: Introduction, Internal energy levels, Microstates, Macrostates and Probability, Case or repeated trials, Phase space, combinatorial problems with respects to particles and energy states.

Unit 2: Entropy and Probability: Thermodynamic probability, State of maximum Thermodynamic probability, Microscopic meaning of entropy, Use of Lagrangian multipliers, Stirling's approximation.

Unit 3: Statistical Mechanics: The statistical distribution laws, Maxwell – Boltzmann statistics, The Fermi-Dirac and Bose -Einstein Statistics, Partition functions, Translational, Rotational etc., Applications of physical models.

Unit 4: Statistical Evaluation Of Thermodynamic Properties: Ideal Monatomic gas, Partition function, Calculation of the translational properties of an ideal monatomic gas, Sackur - Tetrode equation, Potential energy function for a diatomic molecule, Rigid rotor harmonic – oscillator approximation, Rotational and vibrational partition functions of ideal polyatomic gases.

Unit 5: Thermodynamic of Irreversible Processes: Irreversible processes, Phenomenological laws, Application of Onsager - reciprocal relations, Seebeck effect, Peltier effect, Thomson effect.

Recommended Books:

1. R.E. Sonntag, G.I. Van Wylen, Fundamental of Statistical Thermodynamics, John Wiley and Sons, New York, 1966.
2. D.A. McQuarrie, Statistical Thermodynamics, Harper and Row Pub. New York, 1973.
3. M.T. Howerton, Engineering Thermodynamics, D. Van Nostrand Co., Inc., New York, 1962.
4. C.L. Tien, J.H. Lienhard, Statistical Thermodynamics, Holt Rinehart and Winston Inc., New York, 1971.
5. J. Otto Beran, Juliana Boerio, Gates Vol I & II, Chemical Thermodynamics: Advanced Applications”, Academic Press, 2000.
6. Reid, Prausnitz, Poling, The Properties of Gases and Liquids, McGraw Hill Publication

ELECTIVE - I (Discipline Specific BCHT)**1. TECHNOLOGICAL ADVANCEMENT IN OLEOCHEMICALS****Unit- 1**

Hydrogenation of oils and fats, Types of processes, methods of manufacture of hydrogen (pure), Types of catalysts and their production, hydrogenation plant. Selective hydrogenation. Quality control in hydrogenation plant.

Unit 2

Manufacture of butter, ghee, margarine, and vanaspati, Trans esterified oils and fats, cooking oils, salad oils and their fatty edible products. Plastic shortening agents and confectionary fats. Causes of rancidity and prevention. Detection of adulteration, winterization of oils and fats.

Unit- 3

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

Unit-4

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

Unit- 5

Detoxification of oil cakes, Manufacture of value added products from oil meals. Utilization of deteriorated deep fried oil for industrial utilization.

Reference Book

1. The Chemical Constitution of Natural Fats, Hilditch T.P., Chapman and Hall Ltd., London.
2. Bailey's Industrial Oil and Fat Products, 6th Edition, Wiley-Interscience Publication, New York .
3. Modern Technology Of Oils, Fats & Its Derivatives, National Institute of Industrial Research, New Delhi.
4. Edible Oils and Fats--A Global Overview of Technological Developments, Guinness Centre, Taylors Lane,, Ireland.

ELECTIVE - I (Discipline Specific BCHT)**2. PROCESS ECONOMICS, UTILITIES AND BYPRODUCTS OF OIL INDUSTRY****Unit- 1**

Industrial pollution and its impact . Magnitude of industrial waste , Legislative regulations. Recycle and reuse of waste water , recovery of by/c0-product from industrial effluents.

Unit 2

Components of Costing; Utilities, power , steam, air, water; Cost and analysis of plant e.g. Break Even Point, Rate of Return, Pay Back Period, Depreciation etc

Unit- 3

Utilities in expression, solvent extraction refining plant, hydrogenation plant, a typical other oleo chemical unit. A working layout and calculation of cost of production for above plants

Unit-4

Introduction to by- products of refining industry; Phospholipids, production of industrial and edible grade Lecithin, gums. Manufacture of compound cattle feed; production of protein concentrates and isolates. Re-esterification of fatty acid with glycerin and its trans-esterification for production of biodiesel

Unit- 5

Segregation of deodorizer distillate and isolation of value added products by conventional and molecular distillation and other plants and machinery involved. Classification of effluents of oil and allied industries, GOI specifications of effluents and various treatment techniques

Reference Books:

1. Bailey's Industrial Oil and Fat Products, Edible Oil and Fat Products: Chemistry, Properties, and Health Effects, 6th Edition, John Wiley & Sons, USA.
2. Hand Book of Oils, Fats and Derivatives with Refining and Packaging Technology, Published by Indian Institute of Consultants, Engineers India Research Institute, New Delhi
3. Essential Oils and Culinary Herbs*James E. Simon
4. Industrial Fatty Acids and their Applications," edited by E. Scott Pattison, Reinhold Publ. Corp. New York.
5. Fatty acids; Their chemistry, properties, production and uses Part – III Edited by K.S. Markley

ELECTIVE –I (Discipline Specific)**1. Automotive and Coil Coatings)****Unit 1: Introduction**

Introduction, Automotive and automotive paint market. Materials and Concept in body construction. Surface Treatments of multimetals in automobiles.

Polymeric materials in automotive coatings

Unit 2: Coating systems for automotives

Primers for automotives, Surfacer, Topcoats for automotive industry. Paint for plastics (non-metals). Paint shops and quality control in automotive coatings, Coatings for rail-road engines, passenger cars, freight carrier, truck, bus, etc.

Recent advances in automotive coatings.

Unit 3: Applications and quality control

Application techniques in automotive coatings. Electro-deposition techniques. Defects and their remedies in automotive coatings. Evaluation of automotive coatings.

Unit 4: Coil Coatings

Introduction to coil coatings, requirements of coil coatings, metal pre-treatment processes,

Detail study of binders, pigments and additives for coil coatings.

Unit 5: Coil coating systems:

Primers, Surfacer, and top coat formulation for coil coatings. Application techniques.

Recent advances in coil coatings.

PGCHT 104T/4

Credit: 4

ELECTIVE –I (Discipline Specific)

2. Technology of Cosmetics and polishes)

Unit 1:

Nature of human skins and other parts of body. Classification of cosmetics.

Unit 2:

Creams, lotions and face powders, Functions of cream, lotions and face powderRaw materials for cream, lotions and face powders, formulations and evaluations of cream, lotions and face powders.

Unit 3 :

Lipsticks: Functions of lipstick, raw materials, manufacture and evaluations.

Unit 4:

Cosmetic preparation such as eye-make up, Nail lacquers, and polishes.

Unit 5:

Hair dyes. Raw materials, preparation, and properties. Evaluation of hair colours.Recent trends and other miscellaneous cosmetic preparations.

FOOD TECHNOLOGY PRACTICAL (P)

Estimation of Reducing and non Reducing sugars by Lane Eynon Method

Proximate analysis of Food Product

Estimation of Protein Content By Folin –Lowry Method

Estimation of Protein Content By Biurett Method

Estimation of Iron Content

Estimation of Phosphorus Content

Estimation of Reducing Sugar By Nelson-Semogyi Method

Estimation of Reducing Sugar By DNS Method

To Determine Ascorbic Acid By 2,6 Dichloroendophenol

Estimation of Starch By Anthrone Method.

Estimation of Amylose & Amylosepectin Content

Immobilization of Invertase Enzyme from Yeast

PGCHT 106P/2**Process Simulation Laboratory (Petrochemical Technology)****Credit : 2****Softwares**

Simulation exercises using

- A) ASPEN software
- B) Fluent code software
- C) Prosim software (steady and unsteady state processes) and
- D) Response Surface Methodology.

List of experiments**Group A**

Simulation exercises using aspen

1. Physical property estimations;
2. Mass and energy balances; handling user specifications on output streams;
3. Simulation of individual units like,
 - I. Mixers
 - II. Splitters,
 - III. Heat Exchangers,
 - IV. Flash Columns,
 - V. Reactors,
 - VI. Distillation Columns Etc.
4. Heat Exchanger Networks
5. Distillation Trains

6. Pipeline Networks
7. Dynamic Simulation
8. Costing and Economic Analysis

Group B

Simulation Exercises Using Prosim Software

9. Steady State Simulation of Unit Operations
 - A. Evaporator
 - B. Plug Flow Reactor
 - C. Cyclone Separator
 - D. Continuous Stirred Tank Reactor
10. Dynamic Simulation of Chemical Processes
 - A. Cascade Control System
 - B. Feed Forward Control
 - C. Ratio Control
 - D. On-Off Control

Group C

Simulation Exercises Using Fluent Code Software

11. To Study Flow Pattern Inside the Various Unit Operation & Processes using Fluent and Work Bench for Grid Generation.

- A. Heat Exchanger
- B. Rotating Disc Contactor
- C. Atmospheric flow simulation
- D. Flow through pipe viz., bends, elbow, valves etc.
- E. Evaporators
- F. Dispersion study

Minimum experiments of 5 from group A, 3 from group B and 3 from group C

List of softwares needed

- A) Aspen Software
- B) Fluent Code Software.
- C) Prosim Software (Steady And Unsteady State Processes).

PGCHT 106P/3

Credit: 2

OIL TECHNOLOGY – PRACTICAL I (P)

1. Estimation of Physico – Chemical properties of Oils and Fats
2. Beliers Test (Turbidity Temp.) Acetic Acid Method
3. Detection of Colour by Tintometer Method
4. Estimation of RM and Polenske Value
5. Extraction of oil by Soxhlet Method
6. Extraction of essential oil by Clevenger's Assembly
7. Isolation and detection of Protein Content from de oiled cake
8. Preparation of Mixed Fatty Acids and its analysis
9. Preparation of Bio-diesel and its analysis
10. Preparation of Malenized oil and its analysis
11. Analysis of Mono and Di glycerides in oil and fats.

12. To prepare the red oxide metal primer and evaluation of its properties
13. To prepare synthetic enamel and evaluation of its properties.
14. To prepare universal strainer and evaluation of its properties.
15. To prepare cleansing creams, lotions and metallic Soaps
16. To prepare lubricating grease
17. To prepare detergent and liquid detergent
18. Analysis of soaps and soap stocks
19. Analysis of detergent, metallic soaps and cosmetics.
20. Analysis of waxes and paints

Reference Books

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

SYLLABUS FOR SECOND SEMESTER M. TECH. (C.B.C.S.)

PGCHT 201T/1

Credit: 4

Advances in Food Science and Technology

- Unit 1:** Functional properties of food macromolecules, their evaluation and modifications, Protein Technology: Protein concentrates, isolates and hydrolysates. Methods of manufacturing protein hydrolysates; Factors affecting quality of hydrolysates; Food uses of hydrolysates; Carbohydrate technology: Functional properties of starch and other polysaccharides, Process technology and food application of dextrans, chemical and enzymatic modification of starch, high fructose corn syrup.
- Unit 2 :** Recent trends in processing of foods such as application of high pressure, low temperature, ohmic heating, and microwave heating, supercritical fluid extraction and membrane separation in food processing Minimal processing of foods, Ohmic heating, pulsed electric field, high-intensity light pulses, radio-frequency heating, microwave, thermo-sonication,
- Unit 3:** Applications of high pressure extrusion in food processing. High hydrostatic processing of foods. Effect on enzymes, microorganisms in various food systems Equipment for batch and continuous processing. Other applications of HPP including thawing
- Unit 4:** Speciality foods such as simulated and restructured foods, functional and health foods, fast foods, space foods, Textured protein gels and expanded products; Simulated milk products; Restructured protein; Nonconventional sources of protein and its Utilizations.
- Unit 5:** Hybrid drying technologies: combined microwave vacuum drying, combining microwave vacuum drying with other processes, equipment for microwave vacuum drying, product quality

degradation during dehydration. Advanced Membrane Technology for water and liquid foods. RTE frozen foods with reference to packaging and Recent developments in Food Processing with focus on Indian Industry

Reference Books:

Advances in food and nutrition research by Steve L. Taylor, 2009

Advances in food research by C.O.Chichester, 1986

Handbook of food and bioprocess modeling by Sablani S., Rahman M, 2007

Advances in food processing and technology by Peter Fellows

Food processing and technology: Principle and practice by P Fellows, Taylor and Francis, 2009

PGCHT 201T/2

Credit: 4

Multicomponent Distillation

Unit 1: Multicomponent Vapor Liquid Equilibria

Rules and Law describing Equilibrium, Vapor Liquid Equilibria – Binary system, Prediction of Binary Vapor Liquid Equilibrium Data from pure component properties, Consistency tests for Binary Vapor Liquid Equilibrium, Ideal Multicomponent systems, Ideal Ternary systems, Non Ideal Vapor Liquid Equilibria – Multicomponent systems, Relationship between Li and Coull and Bonham Vapor Liquid Equilibrium Relations.

Unit 2: Phase Equilibrium for Petroleum Fractions at Super Atmospheric Pressure

Data resources, Analytical Distillation, Equilibrium Flash Vaporisation, Empirical Correlations, EFV Correlations, ASTM – TBP – EFV Relationships, Pressure effect on EFV curves, EFV Vapor and Liquid Properties.

Unit 3: Phase Equilibrium for Petroleum Fractions at Sub - Atmospheric Pressure

Conversion of ASTM Distillation Assays, Phase Equilibrium for Sub – Atmospheric Pressure, Pressure effect on 30% and 50% Points, Vacuum Phase Diagram Constructions, Consistency between Atmospheric and Vacuum EFV Correlations.

Unit 4: Atmospheric tower

Analysis of crude petroleum and its fraction, Basic processes for Atmospheric Crude Distillation, Separation criteria in petroleum fractionation, atmospheric charge data, Estimate of material balance, Heat and mass transfer balance calculations for type U tower, Heat and Mass Balance calculation for Type R Towers, Heat and Mass Balance calculation for Type A tower, Alternate Procedure for Type A tower calculations.

Unit 5: Vacuum Tower

Types of operations in Vacuum Distillation, Lube or Speciality Vacuum Distillate Operations, Fuels operation, Economic consideration in Vacuum Tower Design, Vacuum Unit Charge Data, Estimate of Material Balance, Lube-Asphalt Operation, Fuels-Pitch Operation, Flash zone and Tower Base Calculations, Flash Zone Pressure, Steam Requirement, Heat Quantities, Heat and mass balance Calculation for Lube-Type Towers, Steam to Product Strippers, Tower Top Condition, Estimate Tower Temperature Profile, Overflash Liquid Condensation section, First

sidestream Product Draw Tray, Second Sidestram Product Draw Tray Tower, Top Sidestream Product Draw Tray, Vapor-Liquid Traffic, Fractionation Analysis, Heat and Material Balance Calculation for Fuels-Type Towers, Temperature Profiles, Overflash Liquid Condensation Section, Sidestream Products condensing Section.

Unit 6: Refinery Light Ends Fractionation

Introduction, Process Design Consideration, Example Design Calculation, Reboiled Absorber.

References:

1. Matthew Van Winkle, Distillation, McGraw Hill Book Company, New York.
2. Wayne C. Edmister, Applied Hydrocarbon Thermodynamics Vol.2, Gulf Publishing Company, Houston.
3. Watkins, R.N “Petroleum Refinery Distillation”, 2nd Edition, Gulf Publishing Company, Texas.

PGCHT 201T/3

Credit: 4

TECHNOLOGY OF SOAPS, DETERGENT AND SURFACTANTS

Unit- 1

Types of soaps, selection of raw materials, physical chemistry of soaps in boiling pan, manufacturing process batch and continuous and the sequences of operations, recent advances in the manufacturing methods. Metallic, transparent & herbal soaps. Analysis of soaps. Quality control during manufacture

Unit 2

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

Unit 3

Surfactants: Classification, chemistry and preparation. Hydrophilic lypophilic balance. Correlation of structure of the surfactant and its performance, manufacture of detergents. Formulation of detergents, wetting agents, foam boosters, dispersing agents.

Unit- 4

Modern developments in the detergent industry. Recent trends and modern developments in the Detergent industry. Biodegradation of detergents, pollution control in soap and detergent utilization

Unit-5

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

Reference Books:

1. The Handbook Of Soap Manufacture, Simmons ,W. H. and Appleton ,H. A. Kindle Books, USA.
2. Soap, Detergent & Perfume Industry, Srivastava S.B ,Small Industry Research Institute, New Delhi.
- 3 . Sulphonation Technology In The Detergent Industry, Herman W. and De Groot, Springer-Verlag New York.
4. Surface Active Agents , Goliath Company, The Gale Group, USA
5. Powdered Detergents , Showell, M. The Procter & Gamble Company, Cincinnati, Ohio, USA.
6. The manufacture of glycerol, by Martin, G. Technical Press, London

7. Soap-Chemistry and Technology, Kane,J. G.,

9. The Manufacture of Soaps, Other Detergents, and Glycerine,Woollatt, Edgar, Mountainview Books, PA, U.S.A.

PGCHT 201T/4

Credit: 4

Manufacturing methods, Machinery, and Planning

Unit 1:

Manufacture of modified drying oils, plants and equipments for varnishes lacquer manufacture.

Unit 2:

General principles of grinding, mixing, dispersion of surface coating. Equipment and machinery for grinding, mixing and dispersion.

Unit 3:

Ball mills, Roll mills, Attritors, Kady mills, Sand mills, Cone mills, Age runners, Amalgamator, planetary and impellor mixing.

Unit 4:

Selection of machinery for manufacture of surface coating including printing inks.

Unit 5:

Project planning. Plant location, planning and layout. Planning of disposal of waste.

Preparation of project for manufacture of paint, varnish, lacquer, printing inks.

PGCHT 202T/1

Credit: 4

Food Biotechnology

Unit 1: Production of baker's yeast; Lactic starter cultures, Physiology and biochemistry of starters, Propagation and management of starters; Production of mushrooms, Spawn production, mushroom harvesting; Production of single cell proteins from algae and bacteria, Product quality and safety, Merits and demerits.

Unit 2: Microbiology and Biochemistry of fermented Foods; Fermented Dairy products such as cheese, yoghurt, sweet curd, paneer, sheekhand; Fermented Cereal/legume products, including bread; Traditional fermented foods like idli, dosa, dhokla,

Unit 3: Raw materials, fermentation and processing of alcoholic beverages; Fruit based alcoholic beverage like wine; Cereal based alcoholic beverage like Beer, distilled beverages gen and whisky. soya based oriental fermented foods soya sauce, Tofu, Tempeh; Fermented pickles.

Unit 4: Production of industrial alcohol, microorganism used, fermentation condition, recovery; lactic acid production, Production of citric acid by surface and submerged culture process; acetic acid, glycerol and acetone butanol by fermentation.

Unit 5: Process technology for Microbial production of Vitamins, Production of Microbial polysaccharides such as Xanthan and Dextran gum production and their application, flavors and fragrances, Industrially produced enzymes from microbial sources and their applications; antibiotics e.g. Penicillin and Streptomycin.

Reference Books:

1. Industrial Microbiology by Casida L. E., John Wiley & Sons Inc New York, 1964
2. Industrial Microbiology by Presscot & Dunn, McGraw Hill Book Co. Inc. New York, 1940
3. Biotechnology B. D. Singh Kalyani Publishers, Ludhiana, 1999.

PGCHT 202T/2

Credit: 4

Process Equipment and Piping Design

Unit 1: Fundamentals of Piping Engineering

Definitions, Piping Components, Their Introduction, Applications. Piping Moc, Budget Codes and Standards, Fabrication and Installations of Piping.

Unit 2: Pipe Hydraulics and Sizing

Pipe Sizing Based on Velocity and Pressure Drop Consideration Cost, Least Annual Cost Approach, Pipe Drawing Basics, Development of Piping General Arrangement Drawing, Dimensions and Drawing of Piping.

Unit 3: Plot Plan

Development of Plot Plan for Different Types of Fluid Storage, Equipment Layout, Process Piping Layout, Utility Piping Layout. Stress Analysis -Different Types of Stresses and its Impact on Piping, Methods of Calculation, Dynamic Analysis, Flexibility Analysis.

Unit 4: Piping Support

Different Types of Support Based on Requirement and its Calculation.

Unit 5: Instrumentation

Final Control Elements; Measuring Devices, Instrumentation Symbols Introduction to Process Flow Diagram (PFD) and Piping & Instrumentation Diagram (P&I)

References:

1. Piping Handbook, 6 Th Edition, M.L. Nayyar, P.E., Mc Graw-Hill, Inc
2. Piping Design Handbook Edited By Johan J Mcketta, Crc Press.
3. Process Modeling Simulation And Control For Chemical Engineers, Luyben, W. L., Mcgraw Hill.

TECHNOLOGICAL ADVANCEMENT OF COSMETICS AND ALLIED PRODUCTS**Unit- 1**

Classification of cosmetics and cosmetic preparations:- Cosmetic preparations such as Shampoos and Conditioners, their Ingredients, types, Functions, formulation, Production techniques, evaluation and safety considerations,

Unit 2

Face care products: Beauty Masks, face creams, Cleansing and Emollient Creams and Lotions, Vanishing Creams, Foundation Makeup., face/body Formulation, Hand Creams and Lotions, Skin Lighteners and Bleach Creams, sun care cosmetics, Rouge, Moisturizing Creams etc.

Unit 3

Face care products: Lipsticks, face powders, talcum powders, Eye makeup cosmetics, Hormone Creams, Bath and shower products Shaving soaps and creams: After shave products, hair oils, hair dyes, Hair Conditioners, brilliantine's.

Unit 4

Dentifrices: Toothpaste, tooth powders, Mouthwashes, teeth whiteners, evaluation of cosmetic preparations, Plant and Machinery used in cosmetic manufacture. Lay out and Hygiene aspect of cosmetic. Miscellaneous Cosmetics, Anti perspirants and deodorants, depilatories, Baby Toiletries, nail lacquers and polishes, recent trends and other miscellaneous cosmetic preparations

Unit- 5

Herbal Cosmetic preparations; Chemical components of herbs & its extraction, Application of herbs & its extracts, Application of herbs in cosmetics application, preservation; Advantages in perfumery: Notes of perfume, compatibility of perfume, fixation and stability of perfume; analysis of perfumes, Medicinal applications of herbal and other essential oils & perfumes.

Reference Books:

1. Handbook of Cosmetic Science and Technology, Barel,A., Paye,M.,Howard I. and Maibach,H. I. Marcel Dekker, Inc.270 Madison Avenue, New York.
- 2.Cosmetics Formulations, Technology & Project Estimations, Institute of Natural & Modern Cosmetech,USA.
3. Cosmetic Formulation of Skin Care Products, Series EditorEricJungermann, Jungermann Associates, Inc. New York.
4. Cosmetics-Science and Technology, Vol-2, 2nd Ed,Sagarin, E. andBalsam, M,Wiley India Pvt. Ltd,New Delhi.
- 5.Analysis of Cosmetic Products,Salvador,E.,Elsevier, New York.

Processing, Application and Technology of Printing Inks**Unit 1:**

Development of printing ink Industry. Nature of various printing process.

Unit 2:

Requirements for topographic, Plano graphic, intaglio, flexographic and silkscreen printing process.

Unit 3:

Relation of rheological and their properties of printing ink with substrate to be printed. Natural of stock of paper.

Unit 4:

Formulations of printing ink, special additives. Nature of additives and its effects on the final performance, special pigments for printing inks.

Unit 5:

Standard of printing inks. Evaluation printing inks. Methods of test.

Special purpose inks, UV-cured inks & modern developments in inks.

PGCHT 203T/1**Credit: 4****Food Safety and Food Regulation**

Unit 1: Types of food hazards: biological, chemical and physical; Risk assessment; Newer systems of safety evaluation such as HACCP. Salient features of Food Safety & Standards Act, 2006, Structure of FSSAI, Administrative set up at the State level. Roles and Responsibilities of diff. Food safety Regulators, Licensing and registration, Documents/ Format required for Registration/ Licensing

Unit 2: Introduction to Food Safety, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labelling (Packaging types, understanding labelling rules & Regulations, Nutritional labelling, labelling requirements for pre-packaged food as per CODEX)

Unit 3: Organic food, Identifying Organic foods, Advantages, The Organic Certification Process, Organic Food labeling, GM food, Why are GM food produced, Main issues of concern for Human Health, How are GM Food regulated Internationally, Regulation in India.

Role of WHO to improve evaluation of GM food, Benefits & Controversies, Irradiated Food, Labelling of Irradiated Food. Freeze dried food, Functional Foods & Nutraceuticals, Functional foods from plant sources, animal sources, dietary supplements, Regulation.

Unit 4: Food & Agriculture Organization (FAO)in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC) Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

Unit 5: Good Hygienic Practices (GHP), Good Manufacturing Practices (GMP), HACCP, ISO 9001 (Quality Management System), ISO 22000 (Food Safety Management System), Traceability, Food Recall Need for Food analysis, Accreditation of Food Laboratory, Referral labs. Risk analysis and management in food safety, What is food surveillance, Steps to be taken for reporting and dealing with food incidents. Food alerts. Offences in food, Trials (Case Study) and procedure to launch prosecution

Reference Books:

Environmental regulation and food safety by Veena Jha.

Microbiological safety of food by Hobbs, 1973

Emerging technologies; food process by Da-wen, 2005

Food safety by Laura K Egenorf, 2000

International standards of food safety by Naomi Rees, David Watson, 2000

Codex alimentarius by FAO & WHO, 2007

Nutritional and safety aspects of food processing by Tannenbaum SR

The food safety information handbook by Cynthia A. Robert, 2009

PGCHT 203T/2

Credit: 4

Petroleum Specialty Products

Unit 1: Lubricating Oil Base Stocks and their Blending:

Conventional Processes, Catalytic Dewaxing, API Classification of Base Oils.

Classification of Lube Oils by Viscosity, additive Types, International Standards, Automotive Engine Oils and their additives, Effect of Viscosity on Fuel Economy, Additive Depletion, Engine Oil Formulation, Effect of Base Stock Quality, API Service Classifications.

Unit 2: Metal Working Fluids:

Types & Functions of MWF's, Cutting Oil Formulation, Maintenance & Disposal.

Quenchants: Heat Treating Processes, Quenching, Types of Quenchants, three stages of Heat Removal, Quench System Design, Other Heat Treating Processes.

Unit 3: Turbine Oils, Gear Oils & Hydraulic Fluids:

Base oils, formulation, life, Test methods.

SAE Gear oil Classification, Automotive lubricant Test Methods, Cold Crank Simulator (ASTM D 5293) and Four Ball Wear Test (ASTM D 4172).

Physical Properties of Hydraulic Fluids, Biodegradability, base oils for Hydraulic Fluids, Brake Fluids.

Unit 4: Lubricating Greases & Waxes:

Grease Composition, Base Oil, Thickeners, Additives, Grease manufacture, Grease Quality, Automotive Greases, Aircraft Greases, Heavy Machinery Greases, Marine Greases, High-Temperature Greases.

Paraffin Waxes, Classification, Properties, Test Methods, Petroleum Wax Manufacture, Non Petroleum Waxes and Petrolatums.

Unit 5: Transformer/ Electrical Insulating Oils & White Mineral Oils:

Properties, Specifications, Transformer Oil Manufacture.

Properties, Uses, Manufacturing of White Oils, Process description, Intermediate Product Nomenclature and Storage, Sulfonate Blending, petroleum Sulfonates,

Unit 6: Bitumen & Carbon Black:

Composition of Bitumen, Bitumen for Pavement, Evaluation, Grading Systems, Hot- Mix Asphalt, Test Methods, Types of Bitumen, Air Blowing Process, Industrial Uses, Storage and Handling.

Manufacturing Processes for Carbon Black viz.Channel Black Process, Gas Black Process, Thermal Black Process, Acetylene Black Process, Lamp Black Process, Furnace Black Process, Reactor, Oxidised Carbon Black, Properties, Secondary Properties, Test Methods, Application and Uses, Printing Inks, Cosmetics Usage.

References:

1. Petroleum Fuels Manufacturing Handbook, Surinder Prakash, Mc Graw Hill.
2. Modern Petroleum Technology, G. D. Hobson & Pohl., Applied Science Publications.
3. Asphalts and Road Materials, Modern Technology, J. E. Parson, Noyes Data Corporation.
4. Lubricant Additives, M. W. Ranney, Noyes Data Corporation.

PGCHT 203T/3**Credit: 4****MODIFICATION OF OIL AND FAT PRODUCTS INCLUDING SURFACE COATINGS****Unit- 1**

Fat Based Products, Industrial lubricants. Bio Lubricants, Lubricant additives, Plasticizers, biodiesel, Lubricating Greases, Manufacture, Properties, types, ingredients, additives, analysis. Fatty Alcohols and Amines

Unit 2

Technology of Drying oils, Chemistry, Thermal and chemical modification methods; Properties and uses, drying, semi drying oils, yellowing of oils : modified oils like heat treated oils, Malenized oils, Co-polymerized oils, dehydration, isomerised oils, segregated, reconstituted oils.

Unit 3

Principles of paint formulations and testing, varnishes and lacquers ,primers, undercoats and finish coats. Manufacture, classification and types of powder coating. Sketches of the machinery used. Manufacture of different types of wall finishes. Convertible and Non-convertible coatings

Unit 4

Technology of Pigments and Extenders, Definition, classification ,Sources, properties, manufacture, testing and evaluation of pigments, preparation and uses of important pigments such as White, yellow, black, blue, green and red pigments, Metallic pigments, Natural organic pigments, comparison of organic pigments, Extenders:- Sources, manufacture, properties and uses,, recent developments.

Unit 5

Solvents and General Paint Properties Hazards and precautions. Diluents, thinners, lacquers-Types, general properties, classification, evaluation of solvents, solubility parameters. Safety measures for coatings, ISI methods of testing of paints, specialty paints, paint film defects, recent developments. Industrial Formulation and Applications of paints

Reference Books:

1. Protective and Decorative Coatings, Paint, Varnishes, Lacquers, and Inks, Mattiello, J. J., John Wiley and Sons, New York.
2. Organic Coating Technology Vol, 1 & 11 by, Payne, H.Y.
3. Paint Technology Manuals., Oil and color chemists Association, Vol-I – Vol. VIII, Chapman and Hall , London
4. Pigment Hand book Vol. 1 – Vol. VIII., Patton, T. C., Wiley-Inter science Publications, New York.
5. The Testing of Paints, Vol – V, Paint Technology Manual,. Dunkley F.G. and Collier, C.W., Chapman and Hall. London
6. Paint film defects and their remedies, Manfred, H., Chapman and Hall Ltd. London.
7. Introduction to paint chemistry – Principles of paint technology, Turner G.P.A., Chapman and Hall , London
8. Outline of paint technology, Morgans, W.M. Edward Arnold Publishers, London

PGCHT 203T/4

Credit: 4

Applications, Evaluation of Surface Coating and Industrial Waste Treatment

Unit1:

Study of metal and nonmetal surfaces for coatings. Surface preparation and treatment.

Unit 2:

Methods of application of paints and the coatings, their advantages and disadvantages.

Plant and equipment used for application. Maintenances of equipments.

Unit 3:

Drying of coating. Analysis and evaluation of paints, varnishes, lacquer, and other coating. Accelerated and exposer tests for coating .I.S.I. standards for coatings.

Unit 4:

Electrodeposition technique anodic & cathodic deposition. Plant for electrodeposition.

Unit 5:

Paint film defects. Methods of improving performance, removal of defects, and correlation of formulation and defect of paint and films.

Safety in paint industry hazard and pollution control.

PGCHT 204T/1

Credit: 4

ELECTIVE - III (Discipline Specific BCHT)

1. Food Industry Waste Management

Unit 1: Standards for disposal of water, physical, chemical and biological characteristics of waste water; measurement of organic content in waste water; Physical unit operations in waste water treatment - screening; racks, mixing, flocculation, sedimentation, floatation, elutriation, vacuum filtration, incineration;

Unit 2: Chemical unit operations in waste water treatment-chemical precipitation, aeration and gas transfer process, rate of gas transfer, adsorption, disinfection; Alternative techniques to reduce the use of chlorine for water treatment, zero-discharge system, zero-emission system , Ion exchange treatment of waste water, Drinking-Water treatment

Unit 3: Biological unit operations - Aerobic and anaerobic treatment of effluents from food processing industry [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds].

Unit 4: Waste management of fruits and vegetable such as production of pectin, ethanol, natural gas, citric acid, activated charcoal, fibre extract from apple pomace, vitamins , Production of citrus oil from peels of citrus fruits; Manufacture of candied peel. Recovery of Protein from potato starch plant waste. Waste management of cereals such as Feed for livestock from wheat and corn bran and germ. Extraction of oil & wax from rice bran, Puffed cereals from broken rice; Starch, modified starch and industrial alcohol from nonusable cereals; Silica from rice husk; Extraction of prolamin (Zein & katirin); Protein from sorghum; Beer spent graining.

Unit 5: Waste management of fish, meat, poultry such as Production of fish meal; Fish protein concentrate; Animal feed; Shell product;Glue from seafood processing waste. Texturised fish protein concentrate (marine beef); Utilization of organs and glands of animal as human food. Production of human food from animal blood and blood protein; Marketable products like chitin, chitosan, fertilizer, nutritional enhancer animal feed from shells. Waste management of Dairy, tea and coffee industry such as Fermentation products from whey. Condensed & dried products from whey; Production of lactose and protein from whey; Utilization of tea waste as feed for livestock & poultry.

Reference Books:

1. The potato in the human diet-Jennifer A Woolfe
2. Edible meat by products- A M Pearson & T R Dutson
3. By products from milk- Webb & Whitier.
4. Fish & Krill protein processing technology- Taneko Suzuki.
5. Processed apple products-Downing
6. Citrus fruits and their products- Ting & Rouseft.
7. Cocoa- Wood & Lass
8. Wheat- Peterson
9. Sweetness & Sweetener- Birch, Green & Coulson.
10. Outlines of Food Technology- Hanx W. VonLoesecke (ab)- Agrabios (India) 2nd Edition, 200 1.

Food Industry Wastes: Disposal and Recovery; Herzka A & Booth RG; 1981, Applied Science Pub Ltd.

Water & Wastewater Engineering; Fair GM, Geyer JC & Okun DA; 1986, John Wiley & Sons, Inc.

Wastewater Treatment; Bartlett RE; Applied Science Pub Ltd.

Symposium: Processing Agricultural & Municipal Wastes; Inglett GE; 1973, AVI.

Food Processing Waste Management; Green JH & Kramer A; 1979, AVI.

Environmental Biotechnology: Principles and Applications; Rittmann BE & McCarty PL; 2001, McGraw-Hill International editions.

Environmental Biotechnology; Bhattacharyya B C & Banerjee R; Oxford University Press.

PGCHT 204T/1

Credit: 4

ELECTIVE - III (Discipline Specific BCHT)

2. Enzyme Technology

Unit 1: Enzymes: classification, properties, coenzymes and cofactors, enzyme kinetics, regulatory enzymes, isoenzymes. Introduction to enzyme technology; Industrial enzymes – present status and opportunities with special reference to food industries;

Unit 2: enzyme inhibition and kinetics of enzyme inhibition, enzyme purification;

Types of enzyme reactions. Catalytic properties of enzymes; Intracellular and extra-cellular enzymes.

Unit 3: Enzyme production technology; Enzyme reactors and process design; Isolation of enzymes from various sources like plant, animals and microbiological.

Unit 4: Cell disintegration by physical, chemical and biological methods; Enzyme purification methods.

Unit 5: Enzyme applications in industry. Application of enzymes for production in biochemical and food processing industries; Application of immobilized enzymes and cells. Advantages and constraints of immobilized enzymes and microbial cells.

Reference Books:

1. Methods of Enzymology
2. Biochemical Engg Fundamentals-Baily, Ollis. MGH
3. Prescott & Dunn's Industrial Microbiology Macmillan
4. Principles of Fermentation Technology-Wittaker and Stanby

ELECTIVE III (Discipline Specific BCHT)**1. Advanced Separation Processes**

Unit 1: Flux Definition, Differential Equations of Mass transfer, Molecular diffusivities, Molecular diffusion, Mass Transfer coefficients

Unit 2: Multicomponent distillation: Bubble point and dew point calculations, Lewis and Matheson calculation, Method of Thiele and Geddes; Azeotropic distillation; Extractive distillation; Molecular distillation; Reactive distillation

Unit 3: Azeotropic and extractive fractional distillation: Separation of homogeneous azeotropes, separation of heterogeneous azeotropes, quantitative treatment of separation of binary heterogeneous azeotropes, selection of addition agents, selectivity, factors affecting selectivity, methods for prediction, mechanism of relative volatility change, choice of entrainer or solvent, design of an azeotropic distillation process, design of an extractive distillation process, methods of solvent recovery

Unit 4: Membrane separation processes: Fundamentals, mechanism and equilibrium relationships, types and structure of membranes, membrane permeation of liquids and gases, effects of concentration, pressure and temperature, dialysis: mechanism, basic idea on dialyser design, industrial application, reverse osmosis, definitions and theory, design considerations, applications, ultra filtration.

Unit 5: Adsorption and Ion Exchange Processes: Adsorption and ion exchange equilibria. Various isotherms. Contact filtration, design of fixed bed adsorber including breakthrough curve.

Recommended Books:

1. R.E. Lacey, S. Loeb, Industrial Processing with Membranes, Wiley –Inter Science, New York, 1972.
2. C.J. King, Separation Processes, Tata McGraw - Hill Publishing Co., Ltd., 1982.
3. C.J. Geankoplis, Transport Processes and Unit Operations, Prentice-Hall of India Pvt. Ltd., New Delhi, 2000.
4. R.E. Treybal, Mass-Transfer Operations, McGraw-Hill, New York, 1980.
5. J.D. Seader, E.J. Henley, Separation Process Principles, Wiley, 2011.
6. B.K. Dutta, Principles of Mass Transfer and Separation Processes, PHI, 2006
7. T.K. Sherwood, R.L. Pigford, C.R. Wilke, Mass Transfer, McGraw-Hill, New York, 1975.
8. H.M. Schoew, New Chemical Engineering Separation Techniques, Interscience Publishers, 1972.
9. Osadar, Varid Nakagawa, Membrane Science and Technology, Marcel Dekkar, 1992.

2. Advanced Process Dynamics & Control

- Unit 1:** Process Identification and Non-Linear Systems. Introduction and analysis of Non-linear control system. Phase plane analysis of second order control system, Analysis of critical points. Method of isoclines for non linear system.
- Unit 2:** Control of complex processes Process modeling and dynamic response of gas absorber, steam jacketed kettle, heat exchanger, distributed parameter model, non-interacting continuous stirred tank reactors, non-interacting stirred tank heaters.
- Unit 3:** Feedforward-feedback control configuration. Industrial examples of feedforward-feedback control of heat exchanger, jacketed continuous stirred tank reactor for exothermic and endothermic reactions, stirred tank heater, distillation column, drum boiler, level control, extraction column.
- Unit 4:** Industrial control system. Control configuration of Supervisory control and data acquisition SCADA, Working control components and network communication of SCADA. Industrial examples of SCADA. Control configuration of distributed control system DCS. Working of Programmable logic controller PLC. Real time monitoring control.
- Unit 5:** Programmed adaptive control, Gain programmed adaptive control. Reference model adaptive control, Inferential control. Industrial examples of adaptive and inferential control. Reaction curve method.

Recommended Books:

1. B. A. Ogunaik, W. H. Ray, Process Dynamics, Modeling and Control, Oxford University Press, NY, 1994
2. B. W. Bequette, Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall International Series, 1998
3. D. E. Seborg, D. A. Mellichamp, T. F. Edgar, F. J. Doyle III, Process Dynamics and Control, 3rd Edition, Wiley.
4. G. Stephanopoulos, Chemical Process Control, Prentice-Hall, Englewood Cliffs, NJ, 1984
5. T. Marlin, Process Control, 2nd Edition, McGraw Hill Inc, US, 2000.
6. R.P. Vyas, Process control and Instrumentation, Seventh Edition, Denett& Co. publication, 2015.
7. R.P. Vyas, Measurement and Control, Denett& Co. Publication 2010.

3. Advanced Chemical Reaction Engineering

Unit 1: Reaction engineering overview- emerging challenges- ideal reactor design equations- multiple reactions, instantaneous and overall yields.

Unit 2: Energy balance in stirred batch, semi-batch and continuous vessels- energy balance in plug flow vessels - optimal design for exothermic reversible reactions - stability and multiplicity of steady states in CSTR.

Unit 3: Design of packed tubular reactors- Gas solid reactions, shrinking core model, pseudo steady state hypothesis for ash layer control, gas solid reactions in rotary kiln and fluid beds.

Unit 4: Non ideal flow, RTD of ideal vessels, modeling non ideal flow, conversion from RTD theory, tanks in series model, dispersion model -catalyst deactivation, design for deactivating catalysts.

Unit 5: Introduction to population balance, application to RTD of CSTR, application to gas solid reactions in Rotary kiln and fluid beds, performance of reactor regenerator system from PBE modeling.

Unit 6: Design for Immobilized cell reactor, design for fermentation alcohol, design for polymerization reactors, biological waste water treatment- flow and reaction through porous media, acid leaching of rocks-liquid liquid reactions-gas liquid reactions , applications in CO₂ capture and global warming.

References:

1. H. Scot Fogler : Elements of Chemical reaction engineering Prentice Hall.
2. J.M. Smith : Chemical Engineering Kinetics, Mcgraw Hill.
3. O Levenspiel : Chemical Reaction Engineering, Wiley.

ELECTIVE III (Discipline Specific BCHT)**4. Environment, Health and Safety in Industries****Unit 1: Introduction**

Need for Developing Environment, Health and Safety Systems in Work Places. Status and Relationship of Acts, Regulations and Codes of Practice .Role of Trade Union Safety Representatives. International Initiatives. Ergonomics and Work Place.

Unit 2: Occupational Health And Hygiene

Definition of the Term Occupational Health and Hygiene. Categories of Health Hazards. Exposure Pathways and Human Responses to Hazardous and Toxic Substances. Advantages and Limitations of Environmental Monitoring and Occupational Exposure Limits. Hierarchy of Control Measures for Occupational Health Risks. Role of Personal Protective Equipment and the Selection Criteria. Effects on Humans, Control Methods and Reduction Strategies for Noise, Radiation and Excessive Stress.

Unit 3: Workplace Safety and Safety Systems

Features of the Satisfactory Design of Work Premises Hvac, Ventilation. Safe Installation and Use of Electrical Supplies. Fire Safety and First Aid Provision. Significance of Human Factors in the Establishment and Effectiveness of Safe Systems. Safe Systems of Work For Manual Handling Operations. Control Methods to Eliminate or Reduce the Risks Arising from the Use of Work Equipment. Requirements for the Safe Use of Display Screen Equipment. Procedures and Precautionary Measures Necessary When Handling Hazardous Substances. Contingency Arrangements for Events of Serious and Imminent Danger.

Unit 4: Techniques of Environmental Safety

Elements of a Health and Safety Policy and Methods of its Effective Implementation and Review. Functions and Techniques of Risk Assessment, Inspections and Audits. Investigation of Accidents- Principles of Quality Management Systems in Health and Safety Management. Relationship between Quality Manuals, Safety Policies and Written Risk Assessments. Records and Other Documentation Required by an Organisation for Health and Safety. Industry Specific Ehs Issues.

Unit 5: Education and Training

Requirements for and Benefits of the Provision of Information, Instruction, Training and Supervision. Factors to be Considered in the Development of Effective Training Programmes. Principles and Methods of Effective Training. Feedback and Evaluation Mechanism.

References:

1. Environmental And Health And Safety Management By Nicholas P. Cheremisinoff And Madelyn L. Graffia, William Andrew Inc. Ny.
2. The Facility Manager's Guide To Environmental Health And Safety By Brian Gallant, Government Inst Publ..
3. Effective Environmental, Health, And Safety Management Using The Team Approach By Bill Taylor, Culinary And Hospitality Industry Publications Services.

ELECTIVE - III (Discipline Specific BCHT)**1. ENVIRONMENTAL ASPECTS OF OIL AND ALLIED INDUSTRIES****Unit 1**

Industrial pollution and its impact . Magnitude of industrial waste , Legislative regulations. Recycle and reuse of waste water , recovery of by/c0-product from industrial effluents.

Unit 2

Philosophy of waste treatment, scope of air and water pollution problems, economic considerations of waste disposal, separation and segregation of wastes, gaseous, liquid and solid waste disposal with special reference to oils and allied product processing.

Unit 3

Waste Management Pollution prevention and environment Management system ISO 14000. Waste audit, Quality management systems, Different regulation means & acts for air , water& solid pollution control.

Unit 4

Waste liquid treatment: Pretreatment methods, centrifugation filtration, evaporator and concentrator , extraction and distillation, treatment of dilute waste water. Treatment requirements, Neutralisation liquid-solid separation, biological oxidation, plant control programme, absorption, liquid phase system, reclamation of waste water effluent and by-product recovery, ion exchange system, acid and alkali purification, continuous ion-exchange,. Case studies on vegetable oil processing, soaps and detergents.

Unit 5

Solid waste treatment, waste gas treatment: spent earth, catalyst, fly ash boiler ash, Air pollution control by mechanical method: mechanical collectors, electrostatic precipitator, filters,wet scrubbers, vapour phase system, activated carbon. Typical air purification system

Reference Books:

1. Narula O.P., “Treaties on fats, fatty acids and oleo chemicals, “Vol I Industrial consultants. (India) New Delhi 1996.
2. Metcalf and Eddy, Wastewater Engineering: Treatment, Disposal and Reuse, Tata McGraw-Hill Pub. Co. Ltd., New Delhi, 1979.
3. S.P. Mahajan, Pollution Control in Process Industry, Tata McGraw Hill Publishers, 1987.
4. G.N. Pandey, G.C. Camey, Environmental Engineering, Tata McGraw-Hill Pub.Co.Ltd., 1992.
5. H.S. Peavy, D.R. Rowe, G. Tchobanoglous, Environmental Engineering, McGraw-Hill, 1986.
6. C.N. Sawyer, P.L. McCarty, G.F. Parkin, Chemistry for Environmental Engineering, Tata-McGraw-Hill Edition, 2003.
7. S.K. Garg , Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 2010.
- 8.

ELECTIVE - III (Discipline Specific BCHT)**2. POLYMERIC SURFACTANTS****Unit 1**

Classification of surfactant, Surface tension and surfactant mechanism, types of surfactants. Basic concepts in surfactants

Unit 2

Development of synthetic detergent industry, principle groups of synthetic detergent industry, Current trends and recent scenario of detergent industry

Unit 3

Alternative surfactant, their functional properties, reaction mechanism, production methods, and their industrial uses, polymeric surfactant based on carbohydrates, vegetable oils and natural rosin

Unit 4

Mechanism of Polymeric surfactant as a substitute for phosphates, release agent, emulsifier, dispersion stabilizer, anti redeposition agent

Unit 5

Biodegradability study of polymeric surfactant, environmental affect compared to traditional raw materials in cleaning industry. Economical aspects

Reference Books:

1. Paolo Zini, "Polymeric Additives for high performing detergent", Technomic publication, U.S.A. 1995
2. Suri S.K., "Synthetic Detergent Powders: Changing Trends – 1, Soaps, Detergent & toiletries Review, p 14-18, Sept. 2000.
3. Hui Y.H., "Bailey's Industrial oil and fats products", 5, p. 78-80, Fifth edition, John Wiley and Sons, Inc, New York, 1996.
4. Mani V.V.S., Shitole A.D., "Fats oleo chemicals and Surfactants, challenges in the 21st Century", Oxford and IBH publishing Co. Pvt. Ltd., New Delhi, 1997.
5. Schwartz A.M. & Perry J.W., "Surface active agents. Their Chemistry and Technology". Interscience Publishers, Inc. New York p 51, 1949
6. Harris J.C. "Detergency Evaluation and Testing", Interscience Publishers, Inc, New York, 1954.

ELECTIVE –III (Discipline Specific)

**1. Functional Coatings
(Super hydrophobic and self-healing coatings)**

Unit 1:

Introduction to Super-hydrophobicity. Natural Super hydrophobic Surfaces: Introduction, Self-Cleaning Properties Arising from Hierarchical Structures,

Unit 2:

Design of Super-hydrophobic Surfaces: Methods to Prepare Super-hydrophobic Surfaces. Super-hydrophobic Polymers/binders: Introduction, Design of Super-hydrophobic Polymers.

Unit 3:

Generation and Characterization of Super-Hydrophobic Micro- and Nano-structured Surfaces. Pigments and other additives for super-hydrophobic coatings. Formulations super-hydrophobic coatings

Unit 4:

Introduction of Self-healing. Release of Healing Agents, Microcapsule Embedment Miscellaneous Technologies , Nanoparticle migrations, Self-healing Polymers and Polymer Composites: Introduction, Preparation and Characterization of the Self-healing Agent Consisting of Microencapsulated Curing Agents, Characterization of the Microencapsules

Unit 5:

Self-healing Protective Coatings: Self-healing Coating-based Active Corrosion Protection, Conductive Polymer Coatings, Active Anticorrosion Conversion Coatings, Protective Coatings with Inhibitor-doped Matrix. Self-healing Anticorrosion Coatings based on Nano-/ Microcontainers of Corrosion Inhibitors

ELECTIVE –III (Discipline Specific)

2. Chemistry and Technology of Nano-pigments

Unit 1:

Importance of nano- pigments in coatings.

Unit 2:

Natural nano-materials, fullerenes, applications, (filtrations, biomedical, textiles, electrical and optical) modifications.

Unit 3:

Synthesis, applications & treatments of nano-silica & analogues materials, silver, ZnO₂, gold, nano-fibers, single and MW- CNTs, iron oxide etc

Unit 4:

Different methods of characterization of nano materials. Self assembled layers, Issues related to handling of nano-materials etc.

Unit 5:

Recent advances in nano-materials used in coating industries. Properties of coatings based on nano-pigments.

PGOPEN 301T

Credit: 4

ELECTIVE IV :