



हरकोर्ट बटलर प्राविधिक विश्वविद्यालय

नवाबगंज, कानपुर - 208002, उ.प्र., भारत

HARCOURT BUTLER TECHNICAL UNIVERSITY

NAWABGANJ, KANPUR - 208002, U.P., INDIA

(Formerly Harcourt Butler Technological Institute, Kanpur)

Phone : +91-0512-2534001-5, 2533812, website : <http://www.hbtu.ac.in>, Email : vc@hbtu.ac.in



1.1.1 Curricula developed and implemented have relevance to the local, national, regional, and global developmental needs which are reflected in Programme Outcomes (POs), Programme Specific Outcomes (PSOs), and Course Outcomes of the programs offered by the University

Department of Mechanical Engineering

Programme Outcomes(POs)		Graduate Attributes (GAs)
PO1.	Apply the knowledge of mathematics, science, engineering fundamentals, and Engineering concepts for the solution of complex Engineering problems	Engineering Knowledge
PO2.	Identify, formulate, review the literature and analyze complex problems related to mechanical engineering reaching substantiated conclusions using the first principles of mathematics and engineering sciences.	Problem Analysis
PO3.	Design solutions for complex problems in mechanical engineering and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations	Design/Development of solutions
PO4.	Use research-based knowledge and research methods including design of experiments, analysis, and interpretation of data, and synthesis of the information to provide valid conclusions.	Conduct Investigations of complex problems
PO5.	Create, select, and apply appropriate techniques, resources, and modern engineering tools such as optimization techniques, simulations, including prediction and modeling to complex process Engineering problems with an understanding of their limitations.	Modern Tool Usage
PO6.	Apply contextual knowledge with justification to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering and mechanical engineering professional practice	The Engineer & Society
PO7.	Environment and sustainability: An ability to understand the principles, commitment, and practice to improve product sustainable development globally in mechanical engineering with minimal environmental effect.	Environment and Sustainability
PO8.	Apply ethical principles and commit to professional ethics adhering to the norms of the mechanical engineering practice	Ethics
PO9.	Function effectively as an individual, and as a member or leader in diverse teams, and multidisciplinary settings	Communication

(Dr. Lalit Kumar Singh)
Dean of Academic Affairs



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PO10.	Communicate effectively on complex engineering and mechanical engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	Individual and Teamwork
PO11.	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	Lifelong Learning
PO12.	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage mechanical engineering projects and in multi-disciplinary environments.	Project management & Finance

Department of Mechanical Engineering

Program Specific Outcomes (PSOs)

By the completion of B. Tech. Mechanical Engineering program, the students will achieve the following program specific outcomes:

PSO 1 Identify, formulate and analyze complex engineering problems in thermal engineering, design engineering, manufacturing engineering and allied domains.

PSO 2 An ability to find out, articulate the local industrial problems and solve with the use of mechanical engineering knowledge and skills for realistic outcomes.

PSO 3 An ability of collaborative learning to find out effective and optimal solution for sustainable growth of mechanical systems.

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NON-CONVENTIONAL ENERGY RESOURCES & UTILIZATION (EME469)

Type	L	T	P	Credits
PEC	3	0	0	3

Prerequisite: Basic science courses

Course Objectives:

This course considers the background of depleting fossil fuel reserves and lays emphasis on the utilization of alternative energy sources. This course considers the background of depleting fossil fuel reserves and lays emphasis on the utilization of alternative energy sources for meeting varying requirements and ensure sustainable development, while assessing the impact of both conventional and non-conventional sources of energy on civilization.

Course Outcomes:

Student will be able to

CO1	Understand effect of fossil fuels on global warming and their relative impact on the environment.
CO2	Comprehend the energy scenario of world in general and India in particular along with assessment of potential of alternative sources of energy.
CO3	Design, analyze and develop theoretical framework for use of alternative sources of energy for different applications.
CO4	Evaluate the performance of the various non-conventional and renewable energy sources.
CO5	Understand and analyze recent advancements in energy generations like magneto hydro dynamic power generation, fuel cell technology, hydrogen energy etc. and develop energy management skills.

Course Content:

UNIT-1

Energy resources and their utilization:

Indian and global energy sources, Energy exploited, Energy planning, Energy parameters (energy intensity, energy-GDP elasticity), Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation.

Solar radiations:

Extra terrestrial radiation, Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations, Solar radiation geometry, Flux on a plane surface, Latitude, Declination angle, Surface azimuth angle, Hour angle, Zenith angle, Solar altitude angle expression for angle between incident beam

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and the normal to a plane surface (no derivation), Local apparent time, Apparent motion of sun, Day length, **Solar radiation data for India.**

UNIT-2

Solar energy:

Solar thermal power and its conversion, Solar collectors, Flat plate, Performance analysis of flat plate collector, Solar concentrating collectors, Types of concentrating collectors, Thermodynamic limits to concentration, Cylindrical collectors, Thermal analysis of solar collectors, Tracking CPC and solar swing

Solar thermal energy storage, Different systems, Solar pond.

Applications, Water heating, Space heating & cooling, Solar distillation, solar pumping, solar cooking, Greenhouses, Solar power plants.

Solar photovoltaic system:

Photovoltaic effect, Efficiency of solar cells, Semiconductor materials for solar cells, Solar photovoltaic system, Standards of solar photovoltaic system, Applications of PV system, PV hybrid system.

UNIT-3

Biogas:

Photosynthesis, Bio gas production Aerobic and anaerobic bio-conversion process, Raw materials, Properties of bio gas, Producer gas, Transportation of bio gas, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production, Bio gas applications, Biomass conversion techniques, Biomass gasification, Energy recovery from **urban waste**, Power generation from liquid waste, Biomass cogeneration, Energy plantation, Fuel properties, **Biomass resource development in India.**

Wind energy:

Properties of wind, **Availability of wind energy in India**, wind velocity, Wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Wind energy farms, Economic issues, Recent development.

UNIT-4

Electrochemical effects and fuel cells:

Principle of operation of an acidic fuel cell, Reusable cells, Ideal fuel cells, Other types of fuel cells, Comparison between acidic and alkaline hydrogen-oxygen fuel cells, Efficiency and EMF of fuel cells, Operating characteristics of fuel cells, Advantages of fuel cell power plants, Future potential of fuel cells.

Tidal power:

Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy Limitations of tidal energy conversion systems.

Hydrogen Energy:

Properties of hydrogen in respect of its use as source of renewable energy, Sources of hydrogen, Production of hydrogen, Storage and transportation,

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Problems with hydrogen as fuel, Development of hydrogen cartridge, Economics of hydrogen fuel and its use.

UNIT-5

Thermoelectric systems:

Kelvin relations, power generation, Properties of thermoelectric materials, Fusion Plasmagenerators.

Geothermal energy:

Structure of earth's interior, Geothermal sites, earthquakes & volcanoes, Geothermal resources, Hot springs, Steam ejection, Principal of working, Types of geothermal station with schematic representation, Site selection for geothermal power plants. Advanced concepts, Problems associated with geothermal conversion.

Ocean energy:

Principle of ocean thermal energy conversion, Wave energy conversion machines, Power plants based on ocean energy, Problems associated with ocean thermal energy conversion systems, Thermoelectric OTEC, Developments of OTEC, and Economics.

Impact of renewable energy generation on environment, Kyoto Protocol, Cost of electricity

Production from different energy sources, Energy options for Indian economy.

Books / Reference:

1. NK Bansal, M Kleemann, M Meliss. Renewable energy sources and conversion technology. TataMcGraw-Hill; 1990.
2. Kothari DP, Singal KC, Ranjan R. Renewable energy sources and emerging technologies. ", Prentice Hall of India Pvt. Ltd. 2011.
3. Rai. G.D. Non-Conventional Energy Sources. Fourth Edition. Khanna Publisher; 2011.
4. AV Desai. Nonconventional energy. vol. 8. Tokyo: New Age International Publishers Ltd; 1990.

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Department of Civil Engineering

Programme Outcomes(POs)		Graduate Attributes (GAs)
PO1.	Apply the knowledge of mathematics, science, engineering fundamentals and Engineering concepts for the solution of complex Engineering problems	Engineering Knowledge
PO2.	Identify, formulate, review literature and analyze complex problems related to civil engineering reaching substantiated conclusions using first principles of mathematics and engineering sciences.	Problem Analysis
PO3.	Design solutions for complex problems in civil engineering and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	Design/Development of solutions
PO4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	Conduct Investigations of complex problems
PO5.	Create, select, and apply appropriate techniques, resources, and modern engineering tools such as optimization techniques, simulations, including prediction and modeling to complex process engineering problems with an understanding of their limitations.	Modern Tool Usage
PO6.	Apply contextual knowledge with justification to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering and civil engineering professional practice	The Engineer & Society
PO7.	Environment and sustainability: An ability to understand the principles, commitment and practice to improve product sustainable development globally in civil engineering with minimal environmental effect.	Environment and Sustainability
PO8.	Apply ethical principles and commit to professional ethics adhering to the norms of the civil engineering practice	Ethics
PO9.	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	Communication

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PO10.	Communicate effectively on complex engineering and civil engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	Individual and Team work
PO11.	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	Lifelong Learning
PO12.	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage civil engineering projects and in multi disciplinary environments.	Project management & Finance

Department of Civil Engineering

Program Specific Outcomes (PSOs)

PSO-1: Able to apply concepts of Civil Engineering to design simple infrastructure such as Building, water tanks, retaining walls, water supply systems, wastewater treatment plants, hydraulic structures, highways, traffic signals problems, landfills, ash ponds etc.

PSO-2: Able to design and conduct civil engineering experiments, as well as to analyze and interpret data.

PSO-3: Exhibit knowledge of basic and applied sciences (Physics, Chemistry and Maths) and apply the same for solving real life civil engineering field problem.

PSO-4: Exhibit an ability to use the techniques, skills, and modern engineering tools necessary for civil engineering practice.

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ENVIRONMENT AND ECOLOGY (ECE-154)

Type	L	T	P	Credits
MC	2	0	0	0

To make students understand and appreciate the unity of life in all its forms, the implication of the life style on the environmental.

Course Objectives:

1. To understand the various causes for environmental degradation.
2. To understand individual contribution in the environmental pollution.
3. To understand the impact of pollution at the global level and also in the local environment.
4. To understand the concept of sustainable development.

Unit-1:

Definition, Scope and importance, Need for Public awareness, Environment definition, Ecosystem, Concept of ecosystem, Structure and function of an ecosystem, Energy flow in ecosystem, Ecological succession, Balanced ecosystem, Human activities, Food shelter, Economic and Social Security.

Effects of Human Activities on Environment: Agriculture, Housing Industry, Mining and Transportation Activities, Basic of Environmental Impact Assessment, Sustainable Development.

Unit-2:

Natural Resources: Water Resources – Availability and Quality Aspects, Conservation of water, Water Borne Diseases, Water induced Diseases, Fluoride problems in Drinking water, Mineral Resources, Forest Wealth, Material Cycles- Carbon, Nitrogen and Sulphur Cycles.

Energy – Different Types of Energy, Electro-magnetic Radiation, Conventional and Non-Conventional Sources, Hydro Electric Fossil Fuel Based, Nuclear, Solar, Biomass, Bio-gas, Hydrogen as an Alternative Future Sources of energy.

Unit-3:

Environmental Pollution: Water Pollution, Land Pollution, Noise Pollution, Public health aspects, Air Pollution, Soil pollution, Marine Pollution, Thermal Pollution, Nuclear Hazards.

Solids Waste Management: Cause, effects and control measures of urban and industrial wastes, Role of an Individual in prevention of pollution, Pollution case studies, Disaster management: Floods, earthquake, cyclone and landslides.

Unit-4:

Current Environmental Issue of Importance, Population Growth, Variation among nations, Population explosion, family welfare Programme, Climate Change and Global Warming- Effects, Urbanization, Automobile pollution, Acid Rain, Ozone Layer Depletion.

Environmental Protection –Role of Government, Legal Aspects, Initiatives by Non- Government Organization (NGO), Environmental Education, Value Education, Human Rights, HIV/AIDS, Women and child welfare, Case Studies.

Course Outcomes:

1. Understand the need for eco-balance.
2. Acquire basic knowledge about global climate change with a particular

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reference to the Indian context.

3. Find ways to protect the environment and play pro-active roles.
4. Involve themselves in activities for environment protection.

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Department of Plastic Technology

Programme Outcomes(POs)		Graduate Attributes (GAs)
PO1.	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	Engineering Knowledge
PO2.	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	Problem Analysis
PO3.	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	Design/Development of solutions
PO4.	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	Conduct Investigations of complex problems
PO5.	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations	Modern Tool Usage
PO6.	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	The Engineer & Society
PO7.	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	Environment and Sustainability
PO8.	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	Ethics
PO9.	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	Communication

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PO10.	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	Individual and Team work
PO11.	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	Lifelong Learning
PO12.	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	Project management & Finance

Program Specific Outcomes (PSOs)

PSO1 : to apply practical skills, technical knowledge in major streams such as chemistry, manufacturing, processing, and applications areas of engineering and technology in plastic and allied industries

PSO2 : to take-up career in research organizations or to pursue higher studies in plastic technology and interdisciplinary programs with high regard for ethical values, environmental and social issues.

PROGRAMME ELECTIVE COURSE III

TPL 452 POLYMER PACKAGING AND WASTE MANAGEMENT

L T P C
3 1 0 4

OBJECTIVE: The objective of this course is to enable the students

- To understand concept of packaging and utility of plastics in packaging.
- To analyze properties of polymers for their utility in packaging of variety of products.
- To know various sources of plastics waste generation and its management.
- To understand the recycling techniques used for various plastics.

Course Outcome

CO1	Understand plastic packaging, scope, advantages and disadvantages of plastic packages, and application of polymer films for packaging.	Understand
CO2	Understand and analyze selection criteria for various household and industrial polymeric packages, their testing and utility on various fields.	Analyze

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CO3	Understand and apply various policies legislation related to plastic waste Management and their effects on environment.	Apply
CO4	Understand recycling technologies for variety of plastics.	Understand and Ethics
CO5	Understand biodegradable polymers and prospects for biodegradable plastics based on renewable resource polymers.	Apply

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3		2				3					3	3	3
CO2	3	2	2			3	3					3	3	3
CO3	3		2	1		3	3					3	3	3
CO4	3		2			3	3	1				3	3	3
CO5	3		2			3	3				1	3	3	3
Total	3	2	2	1		3	3	1			1	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put “-”

Syllabus

Module-I: Elements of packaging

Concept of plastic packaging, present state of packaging technology, scope of packaging, advantages and disadvantages of polymeric packages over conventional packaging materials. Polymer films for packaging.

Module-II: Polymer Packages and Quality Control

Selection criteria of various household and industrial polymeric packages. Printing on polymeric packages. Testing and quality control. Newer developments in polymer packaging.

Module-III: Plastic waste management

Global policies and regulations. Social and environmental challenges of plastic waste in India. Plastics and environment. Salient features of the plastic waste management (PWM) rules. Waste treatment of various plastic plants, estimation of power requirement and efficiency of size reduction operation of plastics.

Module-IV: Recycling Technology

Recycling and recovery of various plastics items/materials-their effect on environment. Waste collection and recycling methods. Comparative study of conversion of plastic waste into value added products.

Module-V: Biodegradable Polymers

Biodegradable polymers - prospects & utilization, prospects for biodegradable plastics based on renewable resource polymers. Biodegradable polymers for various applications viz. food packaging, agriculture, etc.

Reference Books and Suggested Readings:

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1. NP Cheremisinoff, editor. Handbook of Polymer Science and Technology. vol. 4. Taylor & Francis; 1989.2. G Allen, JC Bevington. Comprehensive polymer science: the synthesis, characterization, reactions & applications of polymers. 1989.
2. CR Oswin. Plastics films and packaging. Applied Science Publishers Ltd.; 1975.
3. Science and Technology of Polymer films, by J.F.Hamlin
4. CR Oswin. Protective Wrapping. London: Cam Publications Ltd.; 1954.
5. DV Rosato, RT Schhwartz. Environmental effects on polymeric materials. 1968.
6. Plastic waste management and environment, by V.P.Malhotra
7. Synthetic Rubber Waste Disposal, by L.D.Dougan & J.C.Bell
8. Plastic waste and its recovery, by M.E.Bocqueye

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Department of Oil Technology

Programme Outcomes(POs)		Graduate Attributes (GAs)
PO1.	Apply the knowledge of mathematics, science, engineering fundamentals and Engineering concepts for the solution of complex Engineering problems	Engineering Knowledge
PO2.	Identify, formulate, review literature and analyze complex problems related to Chemical Technology - Oil Technology reaching substantiated conclusions using first principles of mathematics and engineering sciences.	Problem Analysis
PO3.	Design solutions for complex problems in Chemical Technology - Oil Technology and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	Design/Development of solutions
PO4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	Conduct Investigations of complex problems
PO5.	Create, select, and apply appropriate techniques, resources, and modern engineering tools such as optimization techniques, simulations, including prediction and modeling to complex process Engineering problems with an understanding of their limitations.	Modern Tool Usage
PO6.	Apply contextual knowledge with justification to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering and Chemical Technology - Oil Technology professional practice	The Engineer & Society
PO7.	Understand the impact of the professional engineering and Chemical Technology - Oil Technology solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development	Environment and Sustainability
PO8.	Apply ethical principles and commit to professional ethics adhering to the norms of the engineering and Chemical Technology - Oil Technology practice	Ethics

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PO9.	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	Communication
PO10.	Communicate effectively on complex engineering and Chemical Technology - Oil Technology activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	Individual and Team work
PO11.	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	Lifelong Learning
PO12.	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage engineering and Chemical Technology - Oil Technology projects and in multidisciplinary environments.	Project management & Finance

Department of Oil Technology

Program Specific Outcomes (PSOs)

PSO1 : to apply practical skills, technical knowledge in major streams such as chemistry, manufacturing, processing, and applications areas of engineering and technology in plastic and allied industries

PSO2 : to take-up career in research organizations or to pursue higher studies in plastic technology and interdisciplinary programs with high regard for ethical values, environmental and social issues.

TOT-252 Sources, Composition, Characterization of Oils, Fats, and Waxes

L T P C

3 1 2 5

OBJECTIVE: The objective of this course is to enable the students

- To understand concept of packaging and utility of plastics in packaging.
- To analyze properties of polymers for their utility in packaging of variety of products.
- To know various sources of plastics waste generation and its management.
- To understand the recycling techniques used for various plastics.

Course Outcome:

On the successful completion of the course, students will be able to.

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CO1	This gives exposure to various edible, non-edible, commercial oils, fats, and waxes from Animal and vegetable sources.	Understand
CO2	Utilization of oils fats, and waxes as well as storage and handling of oils and oil-seeds.	Apply
CO3	This enables the students to come through the specification and physical & chemical characteristic of the oil occurring naturally from vegetable/animal/marine sources	Apply
CO4	Apply their knowledge to analyze the application of individual oils/fats & their nutritional value for edible application direct or after modification.	Analyze
CO5	To analyze the characteristic and composition of various oils, fat and waxes for their non-edible & industrial purposes.	Analyze

Syllabus:

Module-I

Natural sources of oils and fats

Global and National production, demand and supply scenario of oilseed and oils, Import and export of oils, oilseeds and oil cake, Past trends and future projections in fluctuations of production and price and their reasons.

Module-II

Handling and Storage of Oils and oilseeds

Handling of oilseeds, oil bearing materials and crude oils. Storage of oilseeds, Grading and evaluation of oilseed and oil bearing material as per BIS/ Codex, Drying of oilseed.

Module-III

Commercial oils, oilseeds, cultivation, characteristics, composition and utilization from plant sources

Coconut, palm, palm kernel, olive, cocoa butter, sunflower, safflower, sesame, groundnut, mustard, rape-seed, canola, soybean, niger seed, linseed, castor, rice-bran, cottonseed, corn, tung, oiticica, neem, mahua, kusum, karanja, sal, mango kernel, tobacco, shea fat, watermelon, wheat germ, algae oils, chiasseed oil, jatropha etc. Genetically modified oilseeds

Module-IV

Production, characteristics, composition and utilization of oils from animal sources

Milk fats and butter, lard, tallow other animal fats and greases etc. Fish and marine oils: halibut, herring, shark, menhaden, whale, sardine, fish liver oils, krill oil etc, Different methods of rendering.

Module-V

Natural and synthetic waxes characteristics, composition and utilization

Natural waxes such as bees wax, shellac wax, carnauba wax, sugarcane wax, Montana wax, jojoba wax, sperm-oil, rice bran, sunflower and spermaceti,

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synthetic waxes, their occurrence, classification, general properties and uses.

Module- VI

Laboratory work

Analysis of oilseeds and cakes as per FSSAI/ BIS methods- Moisture Content, Oil Content, Nitrogen/Protein Content, Crude fiber Content, Ash Content

Analysis of extracted oils/ de-oiled cake- FFA, MIV, Color, Flash Point, Phosphatides & wax, poptest, protein, sand & silica, urease activity.

Reference Book

1. AE Bailey. Bailey's Industrial Oil and Fat Products, Edible Oil and Fat Products: Processing Technologies. vol. 5. Sixth. United Kingdom: Wiley; 2005.
2. Products: Processing Technologies Edited by Fereidoon Shahidi, A Wiley-Interscience Publication, JOHN WILEY & SONS, New York. Oils & fats Technology Edited by E. Bernardini
3. Chemical constitutions of natural fats by T.P. Hilditch and P.N. Williams 4th ed., Chapman and Hall (1964)
4. Nontraditional oilseeds and oils by N. V. Bringi, Oxford and IBH Co. Pvt. Ltd. (1989)
5. Fatty Acid by K. S. Markely, Interscience publishers (1968)
6. Analysis of fats and oils by Mehlenbacher V. C., Garrardpren (1960)

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Department of Plastic Technology

NPL 204 POLYMERIZATION ENGINEERING-II (PE-II)

L-T-P-C: 3-0-0-3

OBJECTIVE: The objective of this course is to enable the students

- To understand synthesis, manufacturing process, properties and applications of engineering plastics.
- To learn the manufacturing of high performance thermoset resins and their applications.
- To understand synthesis, manufacturing process, properties and applications of specialty plastics.
- To understand the synthesis and manufacturing of flexible and rigid polyurethanes and analyze their properties and applications.

Course Outcome

On the successful completion of the course, students will be able to

CO1	Understand concept of engineering plastics, synthesis and manufacturing of common engineering plastics and their properties for variety of applications.	Understand
CO2	Understand monomers and their properties, chemistry of synthesis and manufacturing of high performance thermoplastic materials and analyze their properties and utility for variety of application.	Analyze
CO3	Understand concept and characteristics of specialty plastics and their applications.	Understand
CO4	Understand monomers, chemistry of synthesis, manufacturing, curing and properties of high temperature thermoset polymers like epoxy resin, and analyze their properties and utility for variety of applications.	Analyze
CO5	Understand synthesis, manufacturing, properties and applications of specific polymers and analyze their utility to meet desired end use properties.	Understand

Course Articulation Matrix (CO-PO Matrix)

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	3	3
CO1	3	2	1			3	1	1		1		3	3	3

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CO2	3	2	1			3	1	1		1		3	3	3
CO3	3	2	1			3	1	1	1	1		3	3	3
CO4	3	2	1	1		3	1	1		1		3	3	3
CO5	3	2	1	1	1	3	2	1	1	1	1	3	3	3
Total	3	2	1	3	1	3	1.4	1	1	1	1	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put “-”

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Detailed Syllabus

Module-I: Engineering Thermoplastics-I

Definition of engineering plastics and high performance polymers. Monomers, chemistry of synthesis, manufacturing process, properties and applications of common engineering plastics viz, ABS; polycarbonate; Acrylic polymers and copolymers like PMMA, Polyacrylonitrile; Polyacrylamide, etc. effect of these polymers on environment sustainability, global and local manufacturers of these polymers

Module-II: Engineering Thermoplastics-II

Monomers, chemistry of synthesis, manufacturing process, properties and applications of polyamides: Nylon6, Nylon 66, Nylon 11 and aromatic polyamide, polyesters: PET, PBT, fluorine-containing polymers Polytetrafluoroethylene, Polyvinylidene fluoride, Polychlorofluoroethylene, etc. effect of these polymers on environment sustainability. Global and local manufacturers of these polymers

Module-III: Specialty Thermoplastics

Monomers, chemistry of synthesis, manufacturing process, properties and applications of polyphenylene oxide, acetal resins, polysulphones, polysulphides, polyamideimide and other specialty plastics. Effect of these polymers on environment sustainability, global and local manufacturers of these polymers

Module-IV: Thermoset polymers-I

Monomers, chemistry and manufacturing process of thermosetting resins such as epoxy resins, alkyd resins, unsaturated polyesters resins, polyimides: polybismalenimides, polyetherimides, etc. Their curing mechanism; effect of curing parameters on properties and applications of these polymers. Effect of these polymers on environment sustainability, global and local manufacturers of these polymers

Module-V: Thermoset polymers-II

Synthesis and manufacturing of flexible and rigid polyurethanes and their properties and applications. Monomers, chemistry of synthesis, manufacturing process, properties and applications of Silicone polymers. Effect of these polymers on environment sustainability, global and local manufacturers of these polymers

Text Books:

1. Polymer Materials, by J. A. Brydson Butterworth-Heinemann Oxford, 1999
2. Handbook of Plastic Technology, Vol 1, by Allen W. S. CBS Publishers & Distributors, 1988
3. Handbook of Thermoplastics, by Olagoke Olabisi; CRC Press; 2016.
4. Engineering polymers, R.W. Dyson; Chapman Hall NY; 1990
5. Polymer Manufacturing: Technology and Health Effects Hardcover—

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- Import, 1 December 1986; Radian Corporation; Noyes Publications; 1986
6. Industrial Polymers, Specialty Polymers, and Their Applications by Salil K Roy, Manas Chanda, Salil K. Roy, CRC Press, 2019.

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Reference books:

1. Polymer production, by Mayo & Smith, 1975
2. Encyclopedia of Polymer Science & Tech., Vol 1-23, by HF Mark, NM Bikales and CG Over-berger Wiley-Interscience, New York; 1985
3. Handbook of Plastic Technology, Vol 2, by Allen W. S. and G. M. Swallowe, CBS Publishers & Distributors, 2004.
4. Plastics Fabrication and Recycling by Salil K Roy, Manas Chanda, Salil K. Roy, CRC Press, 2019.

Web links:

1. <https://nptel.ac.in/courses/112107221>

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NPL 202 PROCESSING OF POLYMERS –I (PP-I)

L-T-P-C: 3-0-2-4

OBJECTIVE: The objective of this course is to enable the students

- To understand the fundamentals of polymer processing
- To learn the fundamentals of extrusion processes of thermoplastics.
- To learn the basic principle of compounding of thermoplastics
- To learn the fundamentals of calendaring process.
- To learn processing of plastics on different machines and prepare simple plastic articles.

Course Outcome

On the successful completion of the course, students will be able to

CO1	Understand the concepts of Extrusion process of plastic materials.	Understand
CO2	Understand and apply the utility of the single screw and multiple screw extruder systems.	Apply
CO3	Apply knowledge of extrusion process for manufacturing of different extruded plastic products.	Apply
CO4	Understand and apply compounding ingredients and methods for modification of polymer properties.	Apply
CO5	Understand the concept and utility of calendaring process for polymer/plastics.	Understand
CO6	Apply different parameters related to processing machines for formation of plastic products.	Apply

Course Articulation Matrix (CO-PO Matrix)

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	3	3
CO1	3					2						3	3	3
CO2	3					2				1		3	3	3
CO3	3	3	2			2			1	1		3	3	3
CO4	3	2	2	2		2	2	1			1	3	3	3
CO5	3	1	2			2						3	3	3

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CO6	3	3	2	2	1	3	2	1	3	2	1	3	3	3
Total	3	2.5	2	2	1	2	2	1	2	1		3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put “-”

Detailed Syllabus

Module-I: Introduction to Polymer Processing

Principles and concept of Processing of polymers; introduction to different plastic processing techniques Criteria for selection of process for plastics; Factors determining efficiency of plastic

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processing: molecular weight, viscosity and rheology, Difference in approach for thermoplastic and thermoset processing. Sustainability of these processes

Module-II: Fundamentals of Extrusion Process of Polymers

Concepts of Extrusion process for plastics- basic operation and analysis, solids conveying, drag induced conveying, melting mechanism, power consumption in metering zone. Fundamentals of single and twin screw extrusion; Features of Barrel and screw; type of screws, drive mechanism, specifications, heating and cooling systems, Design of screw for commodity, heat sensitive and engineering plastics. Overall extruder performance, die and screw characteristics curves, factors determining efficiency of an extruder. Local and global technological development in extrusion

Module-III: Extrusion Processes for plastic products

Plastic Product formed by extrusion process, Basic principle, equipment used, and process details for plastic extrusion lines for production of Blown film, pipe, tubing, sheet, wire and cable coating, etc.; Utility of these products in urban développement. Extrusion Casting process for films and lamination; Process variables, die design and defects observed in each of the extrusion product. Reactive extrusion: basic principles, equipment used and applications.

Module-IV: Compounding of Polymers

Importance and concept of compounding of polymers; compounding additives viz. fillers, plasticizers, colorants, stabilizers, blowing agents, flame-retardants, antioxidants, lubricants, processing aids, etc. sustainability and effects on environment of variety of additives for plastics Mixing, blending and compounding techniques and equipments. Pelletization, Reactive compounding, Global technical development in compounding additives and compounding technology for plastics. Finishing of Plastics

Module-V: Calendaring of plastics

Calendaring- description and features of calendaring process, calendar roll arrangements, application of calendaring. Production of synthetic leather and coated fabric sheets, Process variables, calendar design and defects observed.

Module VI: Laboratory Experiments

1. Preparation of plastic film on Blown Film Extrusion;
2. Preparation of HDPE plastic pipe on Extrusion;
3. Compounding of PVC on Two Roll Mill;
4. Preparation of sheet by Hydraulic press;
5. Preparation of Fiber reinforced plastic sheet by using glass fiber mat and unsaturated polyester resin

Text Books:

1. Plastics Extrusion Technology, by Grief, Allen L; published by Hassell Street Press, 2021, Hawthorne, U.S.A.

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2. Extrusion of Polymers Theory & Practice, Chan I. Chung; Hanser Publishers, Munich
Hanser Publications, Cincinnati, 2019.
3. Screw extrusion of Plastics, by H

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4. R. Jacobi; London, GB ILIFFE Books Ltd. 1963.
5. Polymer Mixing and Extrusion Technology, by Nicholas Cheremisinoff; First Published 1987; eBook Published 25 October 2017; CRC Press, Available on Taylor and Francis eBooks.
6. Additives for Plastics; J. Stepek and H Daoust; Springer New York; 1983.

Reference books:

1. Plastic Engg. Hand Book of SPI, by Joel Frados, Published July 1st 1976 by Wiley, John & Sons, Incorporated.
2. Plastic Materials and Processes: a concise encyclopedia, by Charles A. Harper and Edward M. Petrie; John Wiley & Sons, 10-Oct-2003
3. Polymer Extrusion 5E; Chris Rauwendaal, Hanser Publishers, Munich Hanser Publications, Cincinnati; 2014.
4. Plastics Additives: An A-Z reference; Editors: Geoffrey Pritchard; Springer Dordrecht; 1998.
5. Plastics Technology Handbook Fifth Edition; Manas Chanda; CRC Press Taylor & Francis Group NY, 2018

Web links:

1. <https://www.twi-global.com/technical-knowledge/faqs/plastic-extrusion>
2. <https://www.extrusion-info.com>
3. <https://www.iqsdirectory.com/articles/plastic-extrusion.html>

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