

Office of Dean of Sustainability
Thapar Institute of Engineering & Technology
(Deemed to be University)
Patiala – 147004 INDIA

Departmental Courses with Sustainability Contents

S. No.	Department	No. of Courses
1	DECE	09
2	DEIE	08
3	DBT	40
4	DEE	14
5	DME	06
6	DPMS	02
7	DCE	06
8	DCSE	01
9	DCHE	01
10	DMOS	00
11	DCBC	10
12	TSLAS	04

Department of Electronics & Communication Engineering

Summary

Sr. No.	Course No.	Course Title	Sustainability Content (%)
1.	UEC310	Information and Communication Theory	20
2.	UEC307	Electromagnetic Field Theory And Transmission Lines	20
3.	UEC640	IOT Based Systems	35
4.	UEC519	Analog and Digital Communication	15
5.	UNC504	Artificial Intelligence	25
6.	UEC719	5G Wireless Communication System	40
7.	UEC520	Machine Learning	30
8.	UEC630	Deep Learning And Applications	30
9.	UEC752	IC Fabrication Technology	20

Sr. No.	Course No.	Course Title	Reproduced Syllabus content related to sustainability	Sustainability content (%)
1.	UEC310	Information and Communication Theory	Stochastic Processes and Noise Modelling. Noise Statistics in Linear Time-Invariant Systems, Noise Power Spectral Densities, Signal-to-Noise-Ratio in Presence of AWGN and Interference; Information Theory: Information Measure and Entropy, Information Source, Coding Strategies, Introduction to Information Channels, Mutual Information and Channel Capacity, Channel Capacity Calculations for Different Channels.	20
2.	UEC307	Electromagnetic Field Theory and Transmission Lines	Electromagnetic wave propagation: Wave Propagation in Lossy Dielectrics, Plane Waves in Free Space, Plane Waves in Good Conductors, Wave Polarization, Energy stored and radiated power. Transmission Lines and Matching Networks: transmission line as circuit and matching elements.Guided waves: Waves between parallel plates, transverse electric waves and magnetic waves.	20
3.	UEC640	IOT Based Systems	IoT Application: Development Solution framework for IoT applications-Implementation of Device integration, Data acquisition and integration IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Home Automation.	35
4.	UEC519	Analog and Digital Communication	Digital Modulation Schemes: Details about Binary-ASK, BFSK, BPSK, QPSK, M-ary ASK, M-ary FSK, M-ary PSK, M-ary QAM; Minimum Shift Keying (MSK), Gaussian MSK (GMSK).	15
5.	UNC504	Artificial Intelligence	Probabilistic Models and Advanced Applications: Introduction to probability theory in AI, Markov models and hidden Markov models (HMMs), Applications of HMMs in speech recognition, Bayes' nets: representation, inference, sampling, Decision	25

			diagrams and the value of perfect information, Machine learning algorithms: Naive Bayes, perceptrons, and clustering, Advanced applications in natural language processing, games, computer vision, and robotics.	
6.	UEC719	5G Wireless Communication System	<p>Physical Layer: Introduction to MIMO, Alamouti scheme, and channel capacity. Waveform in 4G: OFDM, (transmitter and receiver structure at baseband level), numerology of OFDM in LTE and IEEE 802.11, Waveform in 5G, 5G New Radio (NR), Numerology in 5G waveform, Frame structure in 5G NR, Frequency Ranges, Bandwidths, and Bands for 5G NR, Channel Bandwidth versus UE Channel Bandwidth, Overview of waveform beyond 5G, NOMA.</p> <p>5G Network Architecture: Core network architecture, RAN architecture, Main Functional Entities of the 5G Core, High-Level Features of 5G Core, standalone and non-standalone mode, Service data adaptation protocol (SDAP), open RAN, multi-access edge computing (MEC), network function virtualization, Network Slicing, QoS Interworking with Non-3GPP Access Technologies.</p>	40
7.	UEC520	Machine Learning	<p>Supervised Learning: Classification and regression, Decision trees, Random forests, Support vector machines (SVM), Multilayer perceptrons and back propagation.</p> <p>Unsupervised learning: Clustering, Dimensionality reduction, Reinforcement learning using Markov Decision Process.</p> <p>Model selection techniques, Applications of Machine Learning for Signal Processing.</p>	30

8.	UEC630	Deep Learning and Applications	<p>Learning with Memory: Recurrent Neural Network Basics, Advanced Recurrent Neural Networks, Sequential Data Modeling, Embedding Methods for NLP: Unsupervised and Supervised Embeddings, Embedding Methods for NLP: Embeddings for Multi-relational Data, Deep Natural Language Processing</p> <p>Applications: LeNet: Recognizing Handwritten Digits, MiniVGGNet: Going Deeper with CNNs.</p>	30
9.	UEC752	IC Fabrication Technology	<p>MOSFET Technology: Design of MOSFET and CMOS.</p> <p>Packaging of I. C's: Importance of packaging, Mountings in packages using Dual-in-line (DIP) or TO packages. Packages using surface-mount-technology (SMT).</p>	20

Department of Electrical & Instrumentation Engineering

Summary

Sr. No.	Course No.	Course Title	Sustainability Content (%)
1.	UEI805	Environmental Instrumentation	50
2.	UBM702	Hospital Engineering and Management	50
3.	UEN002	Energy And Environment	75
4.	UEE705	Sustainable Energy Systems	50
5.	PEV204	Autonomous Vehicle Technology	30
6.	UEN004	Technologies for Sustainable Development	100
7.	PEV211	Smart Grid for EVs	15
8.	ULC701	Smart Electric Grid and Energy	5

Sr. No.	Course No.	Course Title	Reproduce from Syllabus content related to sustainability	Sustainability Content (%)
1	UEI805	Environmental Instrumentation	Air Pollution: Air pollution control methods and equipment, soil pollution and its effects, Control of specific gaseous pollutants. Water pollution: Instruments used in waste water treatment and control, Latest method of waste water treatment plants Pollution Management: Management of radioactive pollutants, Noise level measurement techniques, Instrumentation techniques in solid waste management, and social and political involvement in the pollution management system.	50
2	UBM702	Hospital Engineering and Management	Planning and Organization of the Hospitals: hospital planning and design, unit-intensive care unit-nursing services. Clinical Services: operation theatre suite pharmacy central sterile supply department. Designing of Hospital Services: water supply and sanitary system- centralized medical gas system Support Services and Safety Management: food service department- laundry and linen service-housekeeping- safety in hospital- fire safety - disaster management. Infection Control and Waste Management: hand hygiene clinical laboratory standards to infection control-health care workers, safety-solid waste management	50
3	UEN002	Energy and Environment	Conventions on climate change Air Pollution Water Pollution Solid Waste Management Ecology and Environment	75
4	UEE705	Sustainable Energy Systems	Wind Energy Solar Energy Energy Mix EVs and Battery Management Systems	50
5	PEV204	Autonomous Vehicle Technology	Comparison between conventional vehicles and electric vehicles; Environmental and economic benefits of electric mobility Autonomous Electric Vehicle Infrastructure and Future Trends Infrastructure requirements for supporting autonomous electric vehicles (charging	30

			stations, communication networks, etc.); Regulatory and policy considerations for the deployment of autonomous electric vehicles; Socio-economic impacts of autonomous electric vehicles on transportation and urban development; Emerging trends and future directions in autonomous vehicle technology and electric mobility.	
6	UEN004	Technologies for Sustainable Development	Concept of Sustainability and Industrial Processes Green Design Renewable and Emerging Energy Technologies	100
7	PEV211	Smart Grid for EVs	Introduction: Introduction, Impact of charging strategies, EV charging options and infrastructure, energy, economic and environmental considerations	15
8	ULC701	Smart Electric Grid and Energy	Architecture of Smart Grid: Functional elements of Smart grid designs, transmission automation, distribution automation, renewable integration. Distribution energy sources, microgrids, storage technologies, electric vehicles and plug-in hybrids, environmental impact, and economic issues. Smart grid architecture, standards policies, network architectures, IP-based systems, power line communications, SCADA system	5

Department of Biotechnology

Summary

Sr. No.	Course No.	Course Title	Sustainability Content (%)
1.	UEN008	Energy and Environment	25
2.	UBT202	Microbiology	15
3.	UBT308	Food Science and Nutrition	15
4.	UBT310	Biochemistry II	10
5.	UBT309	Immunotechnology	10
6.	UBT307	Molecular Biology	5
7.	UPH012	Biophysics and Biomaterials	15
8.	UBT410	Plant Biotechnology	15
9.	UBT408	Genetic & Metabolic engineering	5
10.	UBT409	Animal Biotechnology	10
11.	UBT502	Food processing	15
12.	UBT510	Biology for Engineers	25
13.	UBT514	Natural products	25
14.	UBT516	Bioinformatics	10
15.	UBT517	Bioprocess engineering	10
16.	UBT518	Downstream processing	
17.	UBT619	Pharmaceutical Technology	15
18.	UBT610	Industrial Biotechnology	10
19.	UBT614	Biosafety, bioethics & IPR	15
20.	UBT706	Enzyme Technology	10
21.	UBT802	Nanobiotechnology	15
22.	UBT844	Environmental Biotechnology	60
23.	UBT839	Drug Design and Development	10
24.	PBY105	Recombinant DNA technology	10
25.	PBY107	Trends in Food Industry	10
26.	PBY108	Fermentation & Bio-Separation Technology	5
27.	PBY211	Pharmaceutical Biotechnology	25
28.	PBY212	Nanobiotechnology	20

29.	PBY213	Bioremediation Technology	85
30.	PBY214	Transgenic technologies	20
31.	PBY223	Biomaterials	5
32.	PBY231	Post harvest technology	70
33.	PBY232	Enzyme technology	5
34.	PBT204	Genetic and Metabolic Engineering	15
35.	PBT206	Microbial Technology	85
36.	PBT209	Food Processing	50
37.	PBT301	Animal Biotechnology	10
38.	PBT304	Pharmaceutical Biotechnology	15
39.	PBT305	Plant Biotechnology	20
40.	PBT312	Molecular Farming	90

Sr. No.	Course No.	Course Title	Reproduced Syllabus content related to Sustainability	Sustainability Content (%)
1.	UEN008	Energy and Environment	Solid waste management, energy resources	25
2.	UBT202	Microbiology	Cultivation of microorganisms and microbial physiology	15
3.	UBT308	Food Science and Nutrition	Prevention of food Spoilage, Food Nutrition	15
4.	UBT310	Biochemistry II	Bioenergetics: factors affecting biochemical reactions, biological oxidation-reduction reactions, ATP as energy currency	10
5.	UBT309	Immunotechnology	Health: Vaccine Design and Diagnostic	10
6.	UBT307	Molecular Biology	Applications of molecular biology in agriculture and environment	5
7.	UPH012	Biophysics and Biomaterials	Degradable Biomaterials: types, synthesis, properties, and applications	15
8.	UBT410	Plant Biotechnology	Genetic Modified crop, Drought and disease resistance, nutrient efficiency, molecular farming of commercially/pharmaceutically important products	15
9.	UBT408	Genetic & Metabolic engineering	Production of novel molecules in microbes having therapeutic and industrial applications	5
10.	UBT409	Animal Biotechnology	Gene transfer for production of transgenic animals and varied applications, animal cloning	10
11.	UBT502	Food processing	Factors affecting and prevention methods of food spoilage, packaging of foods	15
12.	UBT510	Biology for Engineers	Energy and Life, nature inspired biomaterials	25
13.	UBT514	Natural products	Natural products of therapeutic, commercial, and household	25

			importance	
14.	UBT516	Bioinformatics	Evolutionary Basis of sequence alignment, biological databases, molecular evolution, and phylogenetics	10
15.	UBT517	Bioprocess engineering	Role of bioprocesses in industry and environment	10
16.	UBT518	Downstream processing	importance of downstream processing in biotechnology, economic evaluation of downstream processing, Industrial case studies	5
17.	UBT619	Pharmaceutical Technology	Drug regulation and control, Current good manufacturing practices and issues, quality control of pharmaceutical products as per pharmacopoeia, biotechnology derived pharmaceuticals	15
18.	UBT610	Industrial Biotechnology	Bio-pigments, Antibiotics, Vitamin	10
19.	UBT614	Biosafety, bioethics & IPR	Biosafety: management of biomedical and hazardous waste, good laboratory practices, risk assessment of GMOs for animal, human, agriculture and environment, Socio-economic impact of biotechnology	15
20.	UBT706	Enzyme Technology	Applications of enzymes: industrial, environmental, and clinical.	10
21.	UBT802	Nanobiotechnology	Environmental, industrial and biomedical applications of nanomaterial	15
22.	UBT844	Environmental Biotechnology	Biological waste water treatment, Solid waste management, Bioremediation and Biodegradation	60
23.	UBT839	Drug Design and Development	Bio-resources for small molecule discovery, biologics, pre-clinical studies	10
24.	PBY105	Recombinant DNA technology	Directed production of small molecules in microorganisms,	10

			Production of novel compounds and diverse chemical structures	
25.	PBY107	Trends in Food Industry	Advanced food packaging: Types of packaging, degradability, reusability and regulations, active and intelligent packaging	10
26.	PBY108	Fermentation & Bio-Separation Technology	Aerobic and anaerobic fermentation processes and their application in biotechnology	5
27.	PBY211	Pharmaceutical Biotechnology	Small molecule drug discovery: Bioprospecting, Plant natural products, Microbial secondary metabolites, animals and marine natural products, preclinical studies, biologic drug discovery	25
28.	PBY212	Nanobiotechnology	Nanotechnology and environmental impact: Potential effects of nanomaterials on human health and the environment, Applications of Nanotechnology in wastewater treatment and water purification, Nanotoxicology, Nanoparticles for environmental remediation.	20
29.	PBY213	Bioremediation Technology	Biodegradation processes, Bioremediation processes and technologies, microbial cleaning of gases	85
30.	PBY214	Transgenic technologies	Transgenic plants and animals for agricultural, industrial, and environmental applications	20
31.	PBY223	Biomaterials	Bioresorbable polymers	5
32.	PBY231	Post harvest technology	Fruits and vegetable, pulses and oilseeds, plantation crops and spices, value addition in crops	70
33.	PBY232	Enzyme technology	Natural sources and environmental applications of enzymes	5
34.	PBT204	Genetic and Metabolic Engineering	Metabolic Engineering: Directed production of small molecules in microorganisms, Production of novel compounds and diverse chemical structures, Case studies	15

			on re-routing of metabolic pathways in microbes, plants and animals	
35.	PBT206	Microbial Technology	Beneficial Soil Microbes, Biogeochemical Cycling, Biotransformation, Microbial Food Products, Microbes and Alternative Sources of Energy	85
36.	PBT209	Food Processing	Food processing, preservation, packaging and quality control	50
37.	PBT301	Animal Biotechnology	Transgenic Animals and Animal Cloning	10
38.	PBT304	Pharmaceutical Biotechnology	Natural products, pharmaceutical testing, analysis and quality control	15
39.	PBT305	Plant Biotechnology	Plant tissue culture, strategies to produce novel plants, secondary metabolite extraction	20
40.	PBT312	Molecular Farming	Strategic Details of Various Molecular Farming, Production of Biodegradable Plastics in Plants	90

Department of Energy & Environment

Summary

Sr. No.	Course No.	Course Title	Sustainability Content (%)
1	UEN003	Energy and Environment (COBS)	80
2	UEN006	Technologies for Sustainable Development	100
3	UEN008	Energy & Environment	60
4	PES116	Elements of Environmental Sciences	25
5	PES117	Wastewater Treatment Technologies	60
6	PES118	Remote Sensing and GIS Applications	15
7	PES111	Air Quality Modelling and Climate Change	20
8	PES205	Air Pollution Control Engineering	40
9	PES206	Water Quality Modelling and Treatment	40
10	PES208	Solid and Hazardous Waste Management	70
11	PES213	Environmental Safety and Management	50
12	PES216	Sustainability and Cleaner Technologies	100
13	PES225	Environmental Legislation and Impact Assessment	60
14	PES227	Environmental Biotechnology	80

Sr. No.	Course No.	Course Title	Reproduced Syllabus content related to sustainability	Sustainability Contents (%)
1	UEN003	Energy and Environment (COBS)	Natural resources and ecosystem Biodiversity: Threats to biodiversity, endangered and endemic species, conservation of biodiversity Social Issues: Sustainable development, environmental ethics, climatic change, environmental protection acts and issues	80
2	UEN006	Technologies for Sustainable Development	Concepts of sustainability and industrial processes: CP, CDM, etc. Product design, recycling and reuse strategies, resources and by-product recovery from waste Green Design: Green building, LEED, GRIHA, etc. Emerging energy technologies	100
3	UEN008	Energy & Environment	Sustainability and sustainable use of natural resources, Conventions on climate change, Ecology and environment, Human population and environment, Renewable energy resources, Composting, and bio-methanation	60
4	PES116	Elements of Environmental Sciences	Environmental systems, Ecosystem, population dynamics and biodiversity, Estimation of water quality parameters	25
5	PES117	Wastewater Treatment Technologies	Wastewater characteristics, Biological Treatment: ASP, SBR, MBBR, MBR, TF, and UASB, Biological nutrient removal, and Sludge management, Recycling and reuse of wastewater, Laboratory work: DO, BOD, COD, MLSS, SVI, etc.	60
6	PES118	Remote Sensing and GIS Applications	GIS: Data base management, spatial references, and image interpretation GIS Application: Data visualization Laboratory Work: Normalized difference vegetation index, digitization, DEM, etc.	15
7	PES111	Air Quality Modelling and Climate Change	Air quality monitoring, and AQI calculation, Climate change, carbon sequestration, and IPCC, Laboratory work: Ambient air monitoring and analyses	20

8	PES205	Air Pollution Control Engineering	Design of industrial ventilation systems, Gaseous emission control, Air pollution mitigation measures, Laboratory work: Efficiency calculation of wet scrubber, adsorption, etc.	40
9	PES206	Water Quality Modelling and Treatment	Physical, chemical, and biological characteristics of water, Rivers, lakes, ground water , and reservoirs, Water treatment technologies: defluoridation, filtration, and household level water purification systems, Laboratory work: Disinfection and TDS reduction	40
10	PES208	Solid and Hazardous Waste Management	Solid waste characteristics, Collection, segregation, transport, and disposal of solid waste, Resource recovery and recycling, Hazardous waste management, Composting, and waste to energy, Laboratory work: Waste characterization, treatment, and analyses	70
11	PES213	Environmental Safety and Management	Hazardous waste disposal methods and their health impacts, OHSAS: 18001, Fire risk identification, assessment and management, Hazard and risk control techniques, Accident prevention and safety	50
12	PES216	Sustainability and Cleaner Technologies	Concept of sustainability, SDGs, models of sustainability, CP, CDM, and carbon credits. Process optimization, Green design: Green building, LEED, GRIHA, etc., Emerging energy technologies	100
13	PES225	Environmental Legislation and Impact Assessment	Convention and protocols, Policy, laws, acts, and rules, EIA, EMP, Environmental auditing and ISO: 14001	60
14	PES227	Environmental Biotechnology	Microbiology of wastewater treatment: Aerobic and anaerobic processes, emerging biotechnological processes in wastewater treatment, etc., Solid and hazardous waste bio-transformations: Sources and management, and microbial biotransformation, Bioremediation and bio-restoration: Bioremediation of contaminated soils and waste land in-situ and ex-situ bioremediation, and phytoremediation, Biofuels: Plant	80

			derived fuels, energy crops, biogas, bioethanol, biohydrogen, etc.	
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Department of Mechanical Engineering

Summary

Sr. No.	Course No.	Course Title	Sustainability content (%)
1	PTH103	Internal Combustion Engines	10
2	PTH202	Refrigeration and Air Conditioning System Design	5
3	PTH209	Applied Solar Energy	80
4	PTH207	Advanced Power Plant Engineering and Industrial Utility	5
5	PTH212	Fuels and Combustion	25
6	UNE 718	Applied Thermodynamics	10

Sr. No.	Course No.	Course Title	Reproduced Syllabus content related to sustainability	Sustainability Content (%)
1	PTH103	Internal Combustion Engines	Alternate Fuels for IC Engines: Liquid alternative fuels, advantages, potential, problems associated with utilization, vegetable oils, bio-diesel, emulsified fuels, effect on lubricating oils, gaseous alternative fuels, hydrogen, compressed natural gas, liquefied petroleum gas, di-methyl ether, multi-fuel engines. Engine Emissions & Control: Air pollution due to IC engines, norms, engine emissions, HC, CO, NOx particulates, other emissions, Emission control methods, exhaust gas recirculation, modern methods.	10
2	PTH202	Refrigeration and Air Conditioning System Design	Refrigerants: Classification of refrigerants, refrigerant properties, secondary refrigerants, ozone depletion potential and global warming potential of CFC refrigerants, eco-friendly refrigerants, azeotropic and zeotropic refrigerants.	5
3	PTH209	Applied Solar Energy	To educate about how to utilize solar energy to achieve the sustainable energy systems. To introduce various types of solar energy collecting devices and their performance analysis. This course also introduces the concepts of photovoltaic cells.	80
4	PTH207	Advanced Power Plant Engineering and Industrial Utility	Non-Conventional Power Generation: Fluidized bed combustion, energy generation through wind, geothermal, tidal and solar energy, IGCC	5
5	PTH212	Fuels and Combustion	Biomass waste to energy. combustion related pollution and control methods vis a vis thermal power plants. alternate fuels CWS . briquetes. biogas from kitchen waste etc	25
6	UNE 718	Applied Thermodynamics	Alternate fuels for IC engines. dual fuel engine run with diesel and producer gas and study of performznce parameters	10

Department of Physics & Material Science

Summary

Sr. No.	Course No.	Course Title	Sustaiianbility Content (%)
1.	UPH062	Nanoscience & Nanomaterials	10
2.	PPH422	Nano-Materials	5

Sr. No.	Course No.	Course Title	Reproduce from Syllabus content related to sustainability	Sustainability Content (%)
1.	UPH062	Nanoscience & Nanomaterials	Nano Materials: Nanotubes and nano-wires, Thin films chemical sensors, Gas sensors, Vapour sensors and Bio sensors. Applications: Photonic crystals, Smart materials, Fuel and solar cells, Opto-electronic devices	10
2.	PPH422	Nano-Materials	Nanomaterials and their applications: Thin film chemical sensors, gas sensors, biosensors, Carbon fullerenes and Carbon nanotubes, Thin film chemical sensors, biosensors, Solar cells, Drug deliveries and optoelectronic devices.	5

Department of Civil Engineering

Summary

Sr. No.	Course No.	Course Title	Sustainability Content (%)
1.	UEN00	Energy and Environment	40
2.	UCE612	Environmental Legislation and Impact Assessment	40
3	UCE837	Sustainable & Smart Materials	70
4	UCE853	Design of Smart & Sustainable Public Utilities	70
5	PCE104	Structural Materials	30
6.	UCE861:	Infrastructure Planning And Design	30

Sr. No.	Course No.	Course Title	Reproduced Syllabus content related to sustainability	Sustainability Content (%)
1.	UEN002	Energy and Environment	<p>Solid waste management: Introduction to solid waste management, Sources, characteristics of municipal and industrial solid waste, Solid waste management methods: Incineration, composting, Biomethanation, landfill, E-waste management, Basal convention.</p> <p>Energy Resources: Classification of Energy Resources; Conventional energy, resources - Coal, petroleum and natural gas, nuclear energy, hydroelectric power; Non-conventional energy resources- Biomass energy,</p> <p>Thermo-chemical conversion and biochemical conversion route; Generation of Biogas and biodiesel as fuels; Solar energy-active and passive solar energy absorption systems; Type of collectors; Thermal and photo conversion applications; Wind energy.</p>	40
2.	UCE612	Environmental Legislation and Impact Assessment	<p>Overview of environmental Legislation: International environmental Conventions and protocols, History of development, Overview of Indian environmental law; Review of Environment and Forest policies of Government of India; Pollution control boards–Powers; functions and Procedures. Judgements on Environment and pollution.</p> <p>Provisions of Water Act; Water-cess Act; Air Act; Environmental Protection Act; Public Liability Insurance Act as Applicable to Industry: Provisions relating to Environmental clearance;</p> <p>Consents from SPCB; Environmental sampling; analysis and Environmental standards; Overview of Other key environmental regulations-Municipal solid waste rules; Biomedical waste rules; Hazardous Waste rules, Chemical accident rules, Batteries rules, fly ash rules, construction and demolition waste rules.</p>	40
3	UCE837	Sustainable & Smart Materials	<p>Course objective: To expose the students to the latest trends in the development of sustainable and smart materials in the field of construction industry based on the efficient</p>	70

			<p>uses of resources.</p> <p>Sustainable Materials</p> <p>Introduction to sustainability concepts and life cycle analysis. Waste management- definitions and legal basis.</p> <p>Nano materials for sustainable construction.</p> <p>Roll of sustainable materials in reduction of carbon emission, Use of sustainable construction materials, significance of material durability in sustainable infrastructure development</p>	
4	UCE853	Design of Smart & Sustainable Public Utilities	<p>Course Objective: This subject aims to design smart and sustainable public utilities such as water supply systems, sanitation & sewer systems, and urban transportation management utilities such as parking & non-motorized traffic (NMT) facilities.</p> <p>Sanitation and Sewer Systems - Management and Disposal Utilities</p> <p>Issues related to Quality of water, Assessment of water demand or quantity of water for various types of demands, Urban Sanitation- systems of sanitation- conservancy and water carriage, Disposal in unsewered areas like septic tanks, privies, Sewerage systems, Pattern of Collection system, sewage disposal, sewage treatment process – screening and skimming, sedimentation, activated sludge process,</p> <p>Sewage sludge treatment Disposal and Utilization. Swachh Bharat Mission as Government Programs related to Sanitation. Urban Storm water collection system and its components, Drainage system: determination of intensity of rainfall and run off coefficient for various sources; rain water harvesting; Reuse and recycling of water</p> <p>Air quality – Management Utilities:</p> <p>Sources, types and effects of air pollution in cavities, urban industrial processes and land use and transportation implications in air pollution. Norms, standards, laws, organizations and policies in urban air quality control. Examples of best practices.</p> <p>Transportation – Management Utilities</p> <p>Roads: Road hierarchy, design control and criteria, geometric design elements, sight distance and control of access; at grade and grade separated intersections. Parking: Parking space norms and standards, design standards for on-street and</p>	70

			<p>off-street parking facilities. Pedestrian Facilities: Capacity guidelines for at-grade and grade separated facilities, design considerations, Comprehensive Mobility Plan Cycling Facilities: Capacity guidelines and design considerations for cycle tracks. Public Transport/ Para Transit Facilities: Design standards for bus stops, auto rickshaw, taxi, cycle-rickshaw stands. Traffic Management measures; Arterial Management; Traffic Signs - principles, types and design considerations, road markings; Traffic Signals - types, optimal cycle length and signal settings, warrants; Regulation of Traffic - speed regulation, regulation of vehicle, parking regulations, Case Studies.</p>	
5	PCE104	Structural Materials	<p>Course Objectives: To understand the mechanism of working of supplementary cementing materials in concrete for production of high performance concrete. Apply waste materials and industrial by-products in the design for sustainable construction.</p>	30
6.	UCE861:	Infrastructure Planning and Design	<p>Strategies for Successful Infrastructure Project Implementation: Introduction to Fair Process and Negotiation, Negotiating with multiple Stakeholders on Infrastructure Projects, Sustainable Development of Infrastructure, Information Technology and Systems for Successful Infrastructure Management, Innovative Design and Maintenance of Infrastructure Facilities, Infrastructure Modelling and Life Cycle Analysis Techniques, Capacity Building and Improving the Governments Role in Infrastructure Implementation. Assignment/ Project: Case study of some successful & sustainable infrastructure projects.</p>	30

Department of Computer Science & Engineering

Summary

Sr. No.	Course No.	Course Title	Sustainability Content (%)
1.	UCS672	Data Science Applications- NLP, CV and IoT	5

Sr. No.	Course No.	Course Title	Reproduced Syllabus content related to sustainability	Sustainability Content (%)
1.	UCS672	Data Science Applications- NLP, CV and IoT	IoT Applications: Smart City, Smart Energy Grids, etc.	5

Department of Chemical Engineering

Summary

Sr. No.	Course No.	Course Title	Sustainability Content (%)
1.	UCH805	Clean Technologies in Process Industries	40

Sr. No.	Course No.	Course Title	Reproduce from Syllabus content related to sustainability	Sustainability Content (%)
1.	UCH805	Clean Technologies in Process Industries	Sustainable Development: Understand Sustainable Development, three principal dimensions: the ecological, use of a systems perspective, to describe sustainability challenges and possibilities for major technical systems and for their transformation to meet sustainability requirements. Resource recovery/by-product recovery, Industrial waste minimization, and Waste Minimization Circles, Hazard Prevention by C.P. Technology Alternatives, Designing Cleaner Production – Green Processes, Cleaner Production and Cleaner Technology implementation	40

Department of Chemistry and Bio-Chemistry

Summary

Sr. No.	Course No.	Course Title	Sustainability contents (%)
1	UCB029	General Chemistry – II	7
2	UCBXXX	Sustainable Chemistry	100
3	UCBXXX	Catalysis	7
4	UCB009	Chemistry	30
5	PCY102	Inorganic Chemistry	7
6	PCY203	Organic Reaction Mechanisms	7
7	PCY307	Catalysis and Reagents	40
8	PCY211	Medicinal and Pharmaceutical Chemistry	
9	PCYXXX	Green Chemistry	100
10	PCY218	Material Chemistry	10

Sr. No.	Course No.	Course Title	Reproduced Syllabus content related to sustainability	Sustainability contents (%)
1	UCB029	General Chemistry – II	Nanoscience and Technology: Introduction to Nanoscience and technology, Synthetic methods, stabilizations, Self-Assembly, Lithography, CNTs and applications of nanomaterials.	7
2	UCBXXX	Sustainable Chemistry	Introduction to Green Chemistry: What is Green Chemistry? Need for Green Chemistry, Goals of Green Chemistry, Limitations, obstacles in the pursuit of the goals of Green Chemistry Principles of Green Chemistry: Twelve principles of Green Chemistry with their explanations and emphasis on atom economy, solvents, energy and catalysis with examples of each. Catalysis: Advantages of catalysts, Photocatalysts, Biocatalyst and their advantages over chemical catalysts with examples of each, Sustainability and biocatalysis. Examples of Green Synthesis/ Reactions and some real world cases: Green Synthesis: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis), Principle of microwave assisted reactions, Hofmann elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; Principle of ultrasound assisted reactions, Simmons-Smith reaction (alternative to Iodine), An efficient green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. Energy, Sources & their Alternatives: Fossil Fuel -Introduction to petrochemicals and Coal, and their applications, Carbon credits, Biofuels, Carbon dioxide emission, Sequestration and valorisation of carbon dioxide and glycerol, Greenhouse gasses, Hydrogen as a greener fuel. Photo switchable compounds and their applications, Solar energy conversion and solar cell.	100
3	UCBXXX	Catalysis	Biocatalysis: Whole cell biocatalysis, enzyme catalysis, and bioinspired molecular design of relevance for artificial photosynthesis.	7
4	UCB009	Chemistry	Water Treatment and Analysis: Physiochemical parameters of water quality, External and internal methods of Softening of water: carbonate, phosphate, calgon and colloidal conditioning, Zeolite process, Ion exchange process, treatment	30

			of water for domestic use, Desalination of brackish water: Reverse osmosis & Electrodialysis. Fuels: biodiesel, Fuel cells: H ₂ production and storage, Water splitting Chemistry of Polymers: biodegradable polymers.	
5	PCY102	Inorganic Chemistry	Application of organometallic compounds as Homogeneous and Heterogeneous Catalysts.	7
6	PCY203	Organic Reaction Mechanisms	Phase transfer catalysis. Regioselectivity	7
7	PCY307	Catalysis and Reagents	Metal-Catalyzed Transformations in Organic Syntheses: Review of basic concepts in catalysis, Reactions of transition metal complexes, The Suzuki coupling, Heck reaction and other Pd-catalyzed reactions, Raney Nickel, Copper catalysis, Ruthenium catalyst, Rhodium catalyst, Buchwald-Hartwig amination, Metathesis reactions, Gold catalysis, Emerging topics (C-H functionalization, borrowing hydrogen).	40
8	PCY211	Medicinal and Pharmaceutical Chemistry	Drug Design: Development of new drugs, Procedures followed in drug design, Concepts of lead compound and lead modification, Concepts of pro-drugs and soft- drugs, Structure-activity relationship (SAR), Factors affecting bioactivity, Resonance, Inductive effect, Isosterism, Bio-isosterism, Spatial considerations. Theories of drug activity: Occupancy theory, Rate theory, Induced fit theory. Concepts of drug receptors. Physico-chemical parameters: Lipophilicity, Partition coefficient, electronic ionization constants, Steric. Free-Wilson analysis, Hansch analysis, Relationships between Free-Wilson and Hansch analysis. LD-50, ED-50.	
9	PCYXXX	Green Chemistry	Introduction: Toxicity of chemicals, chlorine and phosgene controversy. Basic Principles of Green Chemistry: Prevention of Waste/By-Products, Maximum Incorporation of the Reactants into the Final Product, Prevention or Minimization of Hazardous Products, Designing Safer Chemicals, Energy Requirements for Synthesis, Selection of Appropriate Solvent, Selection of Starting Materials, Use of Protecting Groups, Use of Catalyst, Products	100

			<p>Designed Should be Biodegradable, Designing of Manufacturing Plants, Strengthening of Analytical Techniques.</p> <p>Designing a Green Synthesis: Choice of Starting Materials, Choice of Reagents, Choice of Catalysts, Choice of Solvents.</p> <p>Green Chemistry in Day-to-Day Life: Dry Cleaning of Clothes, Versatile Bleaching Agent.</p> <p>Green Reagent: Dimethylcarbonate, Polymer Supported Reagents.Green Catalysts: Acid Catalysts, Oxidation Catalysts, Basic Catalysts, Polymer Supported Catalysts, biocatalyst.</p> <p>Phase Transfer Catalysis in Green Synthesis: Introduction, Applications of PTC in Organic Synthesis, Oxidation Using Hydrogen Peroxide Under PTC Condition, Crown Ethers.</p> <p>Microwave Induced Green Synthesis: Introduction, Applications - Microwave Assisted Reactions in Water, Microwave Assisted Reactions in Organic Solvents, Microwave Solvent Free Reactions (Solid State Reactions).</p> <p>Ultrasound Assisted Green Synthesis: Introduction, Applications of Ultrasound.</p> <p>Aqueous Phase Reactions: Introduction, Diels-Alder Reaction, Claisen Rearrangement, Wittig-Homer Reaction, Michael Reaction, Aldol Condensation, Knoevenagel Reaction, Pinacol Coupling, Benzoin Condensation, Claisen-Schmidt Condensation, Heck Reaction, Strecker Synthesis, Wurtz Reaction, Oxidations, Reductions, Polymerisation Reactions, Photochemical Reactions, Electrochemical Synthesis, Miscellaneous Reactions in Aqueous Phase.</p> <p>Organic Synthesis in Solid State: Introduction, Solid Phase Organic Synthesis Without Using Any Solvent, Solid Supported Organic Synthesis.</p> <p>Versatile Ionic Liquids as Green Solvents: Green Solvents, Reactions in Acidic Ionic Liquids, Reactions in Neutral Ionic Liquids.</p> <p>Synthesis Involving Basic Principles of Green Chemistry: Introduction, Synthesis of Ibuprofen and Styrene. Marine Antifoulant.</p> <p>Recent literature examples of conventional Vs green synthesis.</p>	
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10	PCY218	Material Chemistry	Nanomaterials: Basic Concepts of Nanoscience and Nanotechnology, Types of nanomaterials, Optoelectronic and physicochemical properties, Band energetic and surface structural properties, Applications of nanomaterials.	10
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Thapar School of Liberal Arts and Sciences

Summary

Sr. No.	Course No.	Course Title	Sustainability Contents (%)
1.	NE2403	Sustainable Development: Issues and Challenges	100
2.	NE3401	Biomimetics and Sustainable Design	90
3.	NE3404	Cleaner Production and Sustainable Technologies	90
4.	NE3302	Natural Resources: Conservation and Management	90

Sr. No.	Course No.	Course Title	Reproduced Syllabus content related to sustainability	Sustainability Contents (%)
1.	NE2403	Sustainable Development: Issues and Challenges	<p>Upon successful completion of the course, the students should be able to:</p> <ul style="list-style-type: none"> • Understand the principles of sustainable development, context of sustainability and its importance. • Develop comprehensibility in students various concepts of sustainability in ecology and environment with socio-economic perspectives. • Comprehend the transdisciplinary understanding of socio-ecological, socio-economic and other allied issues for the environmental problems. • To be aware of different United Nations Sustainable Development Goals and its needs. • Critically understand the associated challenges of developing a sustainable society in a practical sense. 	100
2.	NE3401	Biomimetics and Sustainable Design	<p>On the completion of course, students will be able to:</p> <ul style="list-style-type: none"> • Explain biomimetics & provide illustrations from nature that are explored for human development. • Explain nine fundamental laws of nature by Janine Benyus. • Expound processes of biomimicry complementing sustainable design. • Discuss plausible solutions for developing and improving avenues to design products, systems and cities through biomimetics. 	90
3.	NE3404	Cleaner Production and Sustainable Technologies	<p>Upon completion of the course, the students will be able to:</p> <ul style="list-style-type: none"> • Comprehend basic concepts in source reduction, waste treatment and management • Identify and plan cleaner production flow charts/processes for specific industrial sectors 	90

			<ul style="list-style-type: none"> • Examine and evaluate present and future advancements in emerging and renewable energy technologies and green buildings 	
4.	NE3302	Natural Resources: Conservation and Management	<p>On completion of the course, the students would be able to:</p> <ul style="list-style-type: none"> • Distinguish the types of resource reserves and the need for their conservation • Classify various resources and extrapolate their exploitation to environmental impacts • Illustrate the resource consumption and management strategies with suitable examples 	90