Veermata Jijabai Technological Institute

Information of Multidisciplinary Minors for Second year students of A.Y 2025-26

1.Title: Minor in Smart and Intelligent Structures

Minor will be offered to: - **Computer/IT, Electronics/EXTC, Electrical, Mechanical, Production, Civil, Textile**

Course No	Name of the Course	Brief Curriculum.
Minor 1 Sem III	Advanced Materials for Smart and Intelligent Structures	➢ Brief Introduction of Civil Engineering and different types of the structures ➢ Fundamentals of smart materials and their applications in engineering. ➢ Properties and characteristics of smart materials such as shape memory alloys, piezoelectric materials, and magneto strictive materials. ➢ Integration of smart materials into structural components ➢ Case studies showcasing innovative applications of smart materials in engineering.
Minor 2 Sem IV	Sensors, Actuators and Control System for Smart and Intelligent Structures	➢ Types of sensors and actuators used in intelligent structures ➢ Sensor technologies for measuring structural parameters such as strain, deformation, and temperature. ➢ Actuator technologies for controlling structural behaviour and response. ➢ Basics of feedback control systems. ➢ Introduction to structural control strategies such as active, passive, and semi-active control. ➢ Design and implementation of control algorithms for improving structural performance and resilience.
Minor 3 Sem V	Applications of AI, ML, and IoT in Smart and Intelligent structures	➢ Overview of artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT) and their applications in the civil and structural engineering domains. ➢ Machine Learning Fundamentals: Basics of supervised, unsupervised, and reinforcement learning algorithms. Regression, classification, clustering, and anomaly detection techniques. Model evaluation and validation in engineering applications. ➢ IoT-enabled Smart Infrastructure: Introduction to IoT technologies and protocols. Integration of sensors and actuators for real-time monitoring and control of civil infrastructure. IoT platforms and frameworks for managing and analyzing sensor data.
Minor 4 Sem VI	Structural Health Monitoring (SHM):	➢ Principles of SHM techniques including modal analysis, acoustic emission, and guided wave-based methods ➢ Data acquisition and signal processing for SHM. Techniques for collecting and managing data from sensors, monitoring devices, and IoT-enabled infrastructure. ➢ AI and ML Applications in Structural Health Monitoring (SHM): Real-world implementation of SHM systems for damage detection and condition assessment. Predictive maintenance using AI and ML algorithms.
Minor 5 Sem VII	Applications of Smart and Intelligent Structures	➢ AI-driven Design and Optimization in Civil Engineering: Optimization techniques using AI and ML for structural design and analysis. Generative design approaches for creating innovative solutions. Automated decision-making in construction planning and scheduling. ➢ Deep learning algorithms for image analysis and computer vision in civil engineering applications. ➢ Reinforcement learning for autonomous infrastructure maintenance and operation. ➢ Emerging trends and research directions in AI, ML, and IoT for civil and structural engineering. Application to Smart buildings and infrastructure, Aerospace and automotive applications, Biomedical engineering applications, Environmental monitoring and disaster resilience.

2.Title of the Minor: MINOR IN ROBOTICS

Minor will be offered to:- Computer/IT, Electronics/EXTC, Electrical, Mechanical, Production, Civil, Textile

Sr. No.	Name of the Course	Brief Curriculum
1	Introduction to Robotics	**Introduction to robotics** Brief History, Basic Concepts of Robotics such as Definition , Three laws, Elements of Robotic Systems i.e. Robot anatomy, DOF, Misunderstood devices etc., Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc., Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot. **Grippers and Sensors for Robotics** Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper system. Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Need for sensors and vision system in the working and control of a robot. **Drives and Control for Robotics** Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control **Programming and Languages for Robotics** Robot Programming: Methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS etc., Development of languages since WAVE till ROS. **Related Topics in Robotics** Socio-Economic aspect of robotization. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics
2	Mechanics of Robots	**Mathematical Preliminaries of Robotics** Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters. **Robot Kinematics** Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit- Hardenberg Approach, D-H Parameters, Position Representations, Homogeneous Transformation Matrix, Forward Kinematics. Inverse Kinematics, Geometric and analytical approach. **Velocities & Statics** Cross Product Operator for kinematics, Jacobians - Direct Differentiation, Basic Jacobian, , Jacobian Jv / Jw, Jacobian in a Frame, Jacobian in Frame {0}, Kinematic Singularity, Kinematics redundancy, Force balance equation, Forces, Velocity/Force Duality, Virtual Work, Force ellipsoid, Jacobian, Kinematic Singularity, Kinematics redundancy, Mechanical Design of robot linkages, **Path Planning** Definition-Joint space technique, Use of P-degree polynomial-Cubic, polynomial- Cartesian space technique, parametric descriptions,

		straight line and circular paths, position and orientation planning **Robot Dynamics** Introduction to Dynamics, Velocity Kinematics, Acceleration of rigid body, mass distribution Newton's equation, Euler's equation.
3	Microprocessor & Embedded Systems	**Introduction to Embedded Systems and microcomputers** Introduction to Embedded Systems, Embedded System Applications, Block diagram of embedded systems, Trends in Embedded Industry, Basic Embedded System Models, Embedded System development cycle, Challenges for Embedded System Design, Evolution of computing systems and applications. Basic Computer architecture: Von-Neumann and Harvard Architecture. Basics on Computer organizations. Computing performance, Throughput and Latency, Basic high performance CPU architectures, Microcomputer applications to Embedded systems and Mechatronics. **Microprocessor** 8086 Microprocessor and its Internal Architecture, Pin Configuration and their functions, Mode of Operation, Introduction to I/O and Memory, Timing Diagrams, Introduction to Interrupts. Introduction to C language, Instruction format, C language programming format, Addressing mode, Instruction Sets, Programming 8086 microprocessor. **Microprocessor Interfacing** Introduction to interfacing, Memory Interfacing, Programmable Peripheral Interfacing, Programmable I/O, Programmable Interrupt Controller, Programmable Timers, Programmable DMA Controller, Programmable Key Board Controller, Data acquisition Interfacing: ADC, DAC, Serial and parallel data Communication interfacing. Microcontroller: Introduction to Microcontroller and its families, Criteria for Choosing Microcontroller. Microcontroller Architecture, programming model, addressing modes, Instruction sets, Assembly and C programming for Microcontroller, I/O programming using assembly and C language, Interrupt Controller, I/O interfacing, Timers, Real Time Clock, Serial and parallel Communication protocols, SPI Controllers. LCD Controller. **Microcontroller Interfacing** Introduction to Microcontroller Interfacing and applications: case studies: Display Devices, controllers and Drivers for DC, Servo and Stepper Motor. **Introduction to Advanced Embedded Processor and Software** ARM Processor, Unified Model Language (UML), Embedded OS, Real Time Operating System (RTOS), Embedded C. **Microprocessor and Embedded System Laboratories** Basic C language programming implementation on Microprocessor and Microcontroller. Interfacing Displays, Key boards and sensors with Microprocessors and Microcontrollers, Data Acquisition using Microprocessor and Microcontroller, Implementation of Controlling schemes for DC, Servo, Stepper motor using C programming in microprocessors and Microcontrollers.
4	Control of Robotic Systems	**Basics of Control** Differential Equation, Transfer function, Frequency response, Routh-Hurwitz test, relative stability, Root locus design, construction of root loci, phase lead and phase-lag design, lag-lead design, Bode, polar, Nyquist plot. **Linear Control** Concept of states, state space model, different form, controllability, observability; pole placement by state feedback, observer design, P, PI & PID Controller, control law partitioning, modelling and control of a single joint. **Non-Linear Control System** Common physical non-linear system, phase plane method, system analysis by phase plane method, stability of non-linear system, stability analysis by describing function method, Lyapunov's stability criterion, the control problems for manipulators.

		Motion Control Point to Point Control, trajectory generation, Continuous Path Control, Joint based control, Cartesian Control, Force Control, hybrid position/force control system.
5	Wheeled Mobile Robots	

3.Title of the Minor: MINOR IN AEROSPACE TECHNOLOGY

Minor will be offered to:- Computer/IT, Electronics/EXTC, Electrical, Mechanical, Production, Civil, Textile

Sr. No.	Name of the Course	Brief Curriculum
1	An Introduction to Aerospace Engineering	**Atmosphere** Properties and characteristics of the atmosphere **Basic Components of Fixed-Wings Airborne Systems** The fixed wings, control surfaces – ailerons and rudders, their functionality and basic working principles **Introductory Fluid Mechanics & Aerodynamics** Concept of Pressure; A primer on Conservation Laws – Mass, Momentum and Energy. Bernoulli's Principle; A primer on viscous flows and concept of skin-friction; Basic Principle of Lift generation, airfoils – symmetric and cambered; Irrotational flows: Sink, source, doublet & irrotational vortex **Introduction to Propulsion Systems** Primer on the thermodynamic cycles of aircraft engines – ideal and real cycles; Axial Compressors and Turbines; Turbofan, turboprop, turbojet engines; An historical perspective of engines; Rocket engines – the principle of thrust generation with converging-diverging nozzles **Aircraft Performance** Mechanics of flight; Flight stability - considerations of stability in commercial and fighter aircrafts; Glide, climb, ceiling, turn and pull-up; V-n diagram; Range and Endurance **Navigation, Guidance & Control** Brief introduction to radar; Guided missiles, simplified missile guidance laws **Futuristic Aerospace Technologies** Electric propulsion; Hydrogen combustion engines; Supersonic & hypersonic Ramjet/Scramjet
2	Flight and Space Mechanics	**Atmosphere** Properties and characteristics of the atmosphere **Lift and drag on 3D Geometries** 3D Wings; Starting, Bound & Wingtip vortices; Induced Drag; Different kinds of Drag, Center of pressure, Center of Moments. **Performance of Aircrafts** Performance: Level flight, cruise and climb, optimal cruise trajectories, Vn-diagrams; Performance comparison of jet and propeller driven engines. **Stability of Aircrafts** Static longitudinal, directional and lateral stability and control, Stick-fixed and Stick-free stability, Hinge moments, Trim-tabs, Aerodynamic balancing **Manoeuvrability and Control**

		Longitudinal, lateral Control, Control Surface configurations for control, Stall Recovery, Airplane Spin **Space Mechanics** Conic Sections and Central force motion; Orbital Mechanics & Kepler's Laws; Lambert's Problem; Non-Keplerian motion; Orbit Manoeuvres – Hohmann transfer, inclination change bi-elliptic manoeuvres; Lunar/Interplanetary trajectories- sphere of influence.
3	Aircraft Structures	**Introduction to Aircraft Structures** Overview of aircraft structural components: fuselage, wings, empennage, landing gear, etc; types of aircraft structures: semi-monocoque, monocoque, and truss structures; Loads acting on aircraft structures: aerodynamic, inertial, ground, and pressure loads; Material selection for aircraft structures: aluminum alloys, composites, titanium, and steel. **Stress and Strain Analysis** Review of stress and strain concepts; Bending, shear, and torsion in beams; Stress-strain relationships for isotropic and anisotropic materials; Mohr's circle for stress and strain transformation. **Structural Load Analysis** Airworthiness requirements and design criteria; V-n diagram (flight envelope); Load factors and limit loads; Shear force and bending moment diagrams for aircraft wings and fuselage. **Analysis of Thin-Walled Structures** Thin-walled pressure vessels; Shear flow in thin-walled beams; Torsion of thin-walled closed and open sections; Bending and shear stress distribution in thin-walled beams. **Structural Stability and Buckling** Euler's buckling theory; Buckling of columns and plates; Local and global buckling in aircraft structures; Post-buckling behavior and design considerations. **Fatigue and Fracture Mechanics** Fatigue loading and S-N curves; Crack initiation and propagation; Stress concentration factors; Damage tolerance and fail-safe design principles. **Composite Materials in Aircraft Structures** Introduction to composite materials: fibers, matrices, and laminates; Mechanical properties of
4	Aerodynamics	**Introduction to Aerodynamics** Basic fluid properties: density, viscosity, compressibility, and thermal conductivity; Flow characteristics: laminar and turbulent flow, steady and unsteady flow; Continuity, momentum, and energy equations; Dimensional analysis and Buckingham Pi theorem. **Incompressible Flow Over Airfoils** Airfoil nomenclature and geometry; Pressure distribution over airfoils; Lift, drag, and moment coefficients; Thin airfoil theory; Kutta condition and circulation. **Finite Wing Theory** Vortex filament and Biot-Savart law; Downwash and induced drag; Prandtl's lifting line theory; Elliptical lift distribution and wing efficiency. **Compressible Flow** Thermodynamics of compressible flow; Speed of sound and Mach number; Isentropic flow relations; Normal and oblique shock waves; Expansion waves (Prandtl-Meyer flow). **High-Speed Aerodynamics** Subsonic, transonic, supersonic, and hypersonic flow regimes; Critical Mach number and drag divergence; Wave drag and area rule; Shock-expansion theory for supersonic airfoils.

		Boundary Layer Theory Boundary layer concept and characteristics; Laminar and turbulent boundary layers; Boundary layer separation and control; Drag due to skin friction and pressure drag. **Wind Tunnel Testing** Wind tunnel types and their applications; Similarity parameters: Reynolds number, Mach number, and Strouhal number; Measurement techniques for lift, drag, and pressure distribution; Flow visualization techniques.
5	Aerospace Propulsion	

4.Title of the Minor: Contract Law, Arbitration, and Valuation

Minor will be offered to: - Computer/IT, Electronics/EXTC, Electrical, Mechanical, Production, Civil, Textile

Sr. No	Name of the Course	Brief Curriculum
1	Legal Framework for Construction	**Introduction to Construction Law:** Overview of construction law and its importance, Key legal concepts and terminologies, **Legal Frameworks and Regulatory Environment:** Overview of relevant laws and regulations (e.g., Planning and Construction Law of 1965 in Israel) National and international standards and codes **Construction Contracts:** Types of construction contracts, Key clauses and contract negotiation, Contract management and administration **Liability and Risk Management:** Legal responsibilities and liabilities in construction, Risk assessment and mitigation strategies, Insurance and bonding **Construction Dispute Resolution:** Common disputes in construction projects, Mediation, arbitration, and litigation processes, Case studies on dispute resolution **Regulatory Compliance and Ethics:** Compliance with environmental, safety, and building codes, compliance with labour laws, Ethical considerations in construction practice, Professional responsibility and conduct **Emerging Issues in Construction Law:** Impact of technology on construction law, Legal challenges in sustainable construction, Recent legal developments and case studies, Learning Outcomes
2	Contracts, Claims, and Dispute Management	**Introduction to Contract Management** Definition and importance of contract management, Types of contracts and key elements, Contract lifecycle: initiation, execution, and closure **Contract Formation and Negotiation** Key principles of contract law, Drafting and reviewing contracts, Negotiation techniques and strategies **Contract Administration** Effective contract management practices, Roles and responsibilities in contract administration, Monitoring performance and compliance **Claims and Insurance Management** Types of claims and insurances (e.g., delay, disruption, acceleration), Identifying and documenting claims, Claim analysis and preparation **Dispute Avoidance and Resolution** Techniques for preventing disputes, Alternative Dispute Resolution (ADR) methods: mediation, arbitration, Litigation process and strategies **FIDIC Contracts and Claims** Overview of FIDIC contract types, FIDIC claims procedures and management, Case studies on FIDIC disputes **Legal and Ethical Considerations**

		Legal frameworks and regulations impacting contracts and claims, Ethical issues in contract and dispute management, Professional responsibility and conduct **Case Studies and Practical Applications** Real-world case studies and examples, Practical exercises and role-plays, Group discussions and presentations
3	Project Accounting and Cost Management	**Introduction to Project Accounting and Cost Management** Definition and importance, The Project Accountant, Project Pricing Methodologies: Cost Plus Pricing, Fixed Fee Pricing, Contractual Modifiers. **Project Billing and Revenue** Progress Billings, Project Revenue Recognition, Percentage of Completion Method, Completed Contract Method, Contract Modifications, Measurement of Progress Completion. **Construction financing and control** Cost associated with constructed facilities, Techniques for cost estimation, effect of scale on construction cost, Measurement of Progress Completion, cost control in construction. **Project Cost Management** , Progress Monitoring, Cost Variance Reporting, Change Order Management, Allowance Management, Contingency Management, The Sunk Cost Consideration. **Decision Making Tools** Marginal Costing, Techniques of Marginal Costing, Application of Marginal Costing in Decision Making, Differential Cost Analysis, Transfer Pricing, Methods of Transfer Pricing. **Budgeting and Budgetary Control** Budgetary Control and Preparation of Functional and Master Budgeting, Fixed, Variable, Semi-variable Budgets, Financial statements for projects, Zero Based Budgeting (ZBB). **Tools for Financial Analysis and Planning** Financial Ratio Analysis, Fund Flow Analysis, Cash Flow Analysis **Project Measurements** Learning Curve, Cost Variance, Net Present Value, Breakeven Analysis, Return on Assets.
4	Construction Safety, Quality, and Risk Management	**Introduction to Construction Safety** Importance of safety in construction, Common hazards and risks, Regulatory frameworks and safety standards. Basic terminology in safety, types of injuries, safety pyramid. Accident patterns, theories of accident-causation.Personal Protective Equipment (PPE). **Safety Management Systems** Components of a safety management system, Implementing safety protocols, Monitoring and continuous improvement. Types of PPE and their uses, Proper usage and maintenance of PPE, Employer and employee responsibilities. **Planning for safety** Safety budget, safety culture, Introduction to OSHA regulations, Role of stakeholders in safety, Site safety programs - Job hazard analysis, accident investigation & accident indices-violation, penalty. **Construction Quality Management** Definition and importance of quality in construction, Quality control vs. quality assurance, Tools and techniques for quality management. **Standards and Compliance** Industry standards for quality, Compliance with legal and regulatory requirements, Quality certifications and audits. **Risk Management Process** Identifying risks, Analyzing and evaluating risks, Implementing risk controls. Introduction to risk management, Types of risks in construction (e.g., financial, legal, strategic), Risk assessment and mitigation strategies. **Best Practices for Construction Safety and Quality** SoPs (Safe Operating Procedures) – Construction equipment, materials handling-disposal & hand tools. Awareness and training programs, Effective communication and documentation, Use of proper equipment and technology.
5	Appraisal Implementation	**Introduction to Infrastructure Projects**

	for Infrastructure Projects	Definition and importance of infrastructure projects, Types of infrastructure projects (e.g., transportation, energy, water), Overview of the project lifecycle **Project Appraisal Techniques** Feasibility studies, Cost-benefit analysis, Environmental and social impact assessments Risk analysis and management **Financial Analysis and Funding** Financial feasibility and economic viability, Sources of financing (public, private, PPP) Budgeting and financial planning, Investment appraisal techniques (NPV, IRR, payback period) **Legal and Regulatory Framework** Regulatory requirements and compliance, Contracts and procurement processes, Stakeholder engagement and management **Project Planning and Scheduling** Project planning tools and techniques, Work breakdown structure (WBS), Critical path method (CPM) and Gantt charts, Resource allocation and management **Project Implementation** Construction management, Quality assurance and control, Health, safety, and environmental management, Monitoring and evaluation **Project Management Software** Introduction to project management software (e.g., MS Project, Primavera), Application of software in project planning and control, Case studies and practical exercises **Case Studies and Best Practices** Analysis of successful infrastructure projects, Lessons learned and best practices, Group projects and presentations

5.Title of the Minor: **Innovation and Entrepreneurship**

Minor will be offered to: - Computer/IT, Electronics/EXTC, Electrical, Mechanical, Production, Civil, Textile

Sr.No	Name of the Course	Brief Curriculum
1	Understanding Incubation and Entrepreneurship	**Introduction to Entrepreneurship** Definition and importance of entrepreneurship, characteristics of successful entrepreneurs, entrepreneurial mindset and motivation. identifying business opportunities, types of entrepreneurship,. Lean Start-ups. Case studies and success stories of start-ups. **Introduction to Business Incubation** Importance of incubation in the entrepreneurial ecosystem, Types of incubators: technology, social, corporate, etc. Organisational structure of Incubators, Management and Operations, Collaboration and partnership, Funding, Networking , Mentoring, Challenges, Measuring success and KPI's **Innovation & Business development** Creativity and innovation in business ideas, principles and processes of innovation. analysing the current business scenario, application of design thinking in product design , role of technology and sustainability in product design, brainstorming, mind mapping, and other ideation methods, Challenges in Innovation, From Idea to Proof of Concept, Problem statement presentation
		Indian Environment for Entrepreneurship Overview of entrepreneurship in India, historical perspectives and evolution of Indian start up ecosystem, Key sectors and industries driving entrepreneurship in India. Case studies of famous entrepreneurs and their impact, social norms and their impact on entrepreneurial activities. **Exploring funding options** Overview of Entrepreneurial Investment, Types of Investors (Angels, VCs, etc.), Funding stages-seed funding, series A,B,C etc. debt vs equity financing , alternative funding sources (crowdfunding ,grants), Role of Angel Investors, Role of VC's, Role of financial institutions and banks in supporting start ups **Government Policies and Support in India**

		Overview of government policies supporting entrepreneurship (Startup India, Make in India, Atmanirbhar Bharat), Regulatory environment and ease of doing business, Government grants, subsidies, and schemes for startups. Oligopolies and Public Policy **Legal and Ethical Issues** Business law basics,, Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business. Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy. Intellectual property protection , creation & types of IPR, Patents and Copyrights-Patents in India
2	Entrepreneurship Essentials	**Business Model Development** Identifying business opportunities, Creating a Business Model Canvas, Building proof of concept-developing a business model, Components of a business plan, Setting business goals and milestones, Drafting a business plan outline, Value Proposition Design, strategic planning, Intellectual Property, Business Registration and Licensing **Building & Managing a Team** Understanding Employment Law, Team dynamics- assistance with administrative tasks such as accounting, legal issues, and HR., Leadership styles, Recruitment and hiring, benefits of diversity and inclusion, setting and achieving team goals, defining and developing company culture. Tools and technologies for virtual collaboration. Discussions on best practices. Team building activities and exercises **Market Research and Analysis** Market research methods , Identifying Target Markets, Competitor Analysis- Perfect Competition; Monopoly Competition; Oligopolistic Competition. Customer Discovery, customer acquisition and retention, Marketing strategies, Branding and Positioning, Digital Marketing and social media, customer acquisition, budgeting and forecasting, analysis and performance measurement. Case studies on Developing a marketing plan. **Financial Planning and Management** Funding and investment strategies. Creating a business budget, Understanding balance sheets, income statements, and cash flow statements, budgeting and forecasting, Choosing the right funding mix, cost -benefit analysis, break-even analysis, identifying financial risks, strategies for risk mitigation, contingency planning **Resources and Support** Importance of networking in entrepreneurship, Finding and working with mentors and advisors, Investor Relations, Access to co-working spaces, Tools and technologies needed for product development, such as software licenses or lab equipment. Strategies for building professional networks, Building advisory boards **Failures, Resilience and Recovery** Importance of studying failed start-ups , overview of common reasons for failures, Case studies: of Start-ups that failed : -due to poor market fit, due to flawed business models, due to financial mismanagement, due to team issues, due to operational issues, due to customer-related issues, due to competition etc, Building resilience in the face of failure, Overcoming business challenges in entrepreneurship, Case studies: Entrepreneurs who bounced back after failure
3	Product Design and Manufacturing	**Introduction to Product Design** Product -consumption cycle, product realization process, product -design and manufacturing, features, product characteristics, cost and duration of product development ,Rapd prototyping process **Visual Design** Elements of visual design, aesthetic design, design principles-proportion/ratio ,contrast, variety etc, product message, translating customer needs-voice of customer, quality function deployment (QFD)- tools used, product design specifications-components **Value Engineering** Defining value engineering, cost-reduction versus value engineering, reasons for poor value, Value engineering methodology/ job plan phases-information, function, creativity ,evaluation ,development and implementation phase, Function analysis system technique(FAST), Case study **Material Selection** Importance of material selection, Factors affecting the material selection process, Material selection procedures, design recommendations, materials recommended-ferrous/non ferrous, copper/brass, engineering materials etc

		Manufacturing Process & Manufacturing Design Selection of manufacturing process, Primary manufacturing processes, Secondary manufacturing processes, Tertiary manufacturing processes, Design for manufacturing .Design review, DFM & DFA principle, manufacturing guidelines, Computer aided design, Design for Assembly **Product Costing** Cost and Price Structure, Information need-sources, Estimating direct and indirect costs, Design and manufacturing costs, ways to model manufacturing costs-process flow model, parametric cost model **Design for Maintenance** Importance, Factors affecting ease of maintenance, elements and concepts of maintenance, corrective and preventive maintenance, Maintenance of a degrading system
4	Six Sigma	**Introduction to Six Sigma** Quality concepts and definition, History of continuous improvement, Six sigma principles , Historical context and evolution, Key concepts: DMAIC (Define, Measure, Analyze, Improve, Control, Focus area, Six sigma applications **Quality Management Principles** Fundamentals of Total Quality Management (TQM), TQM vs Six Sigma, Cost of quality, Quality function deployment , Management and planning tools **Define and Measure**S Six Sigma Project Identification, Selection and Definition, Project Charter and Monitoring, Process characteristics and analysis, Process Mapping: SIPOC, Data Collection and Summarization, Measurement systems, Fundamentals of statistics, Process capability analysis **Analyze and Improve** Hypothesis testing,Correlation and Regression Analysis, One-Way ANOVA,Two -Way ANOVA, Multivariate analysis, Failure mode effect analysis (FEMA), Fractional factorial design,Taguchi method **Control** Seven QC tools, statistical process control, Operating characterisctics curve for variable controls and attribute control, Design of acceptance sampling for attributes, Design of acceptance sampling for variables **Six Sigma Implementation Challenges** Design for Six Sigma (DFSS)-DMADV, DMADOV,DFX, Team management, Case studies
5	Management Information System	**Introduction to Management Information Systems** Introduction to Management Information systems :Types of MIS, Capabilities, Complements, CCR Framework; Impact of IT on organisations, Information Systems Infrastructure- Hardware, software, and networking components Role of manager with respect to IT in an organization **Database Management Systems** Database management systems, Data Warehousing, Relational database concepts, SQL fundamentals, Data modeling and normalization, Big Data, Knowledge Management- Decision Support Systems, Expert Systems, Learning Management Systems, Executive Information Systems **Strategic Enterprise Systems - ERP, SCM, CRM, SRM.** Strategic Enterprise Systems - Enterprise Resource Planning (ERP) systems, Supply Chain Management (SCM) systems, Customer Relationship Management (CRM) systems **E-commerce and IT Strategy** Mobile and E-commerce – B2C, B2B and e-procurement, C2C and mobile commerce, IT Strategy and Balanced Scorecard – IT strategies, IT-business alignment, cloud and vendor strategies. **Operational Support Systems** Operational Support Systems - Manufacturing Systems, Sales and Marketing Systems, HRIS, Finance and Accounting Systems **Emerging Technologies**

		Emerging Technologies – Cloud computing, Big Data Technologies, Internet of Things, Bring Your Own Device (BYoD,) Virtual Reality, Augmented Reality, Blockchain, Artificial Inelligence **Ethical and Social Issues in MIS** Privacy and data protection, Intellectual property rights, Digital divide and societal impacts.

6. Title of the Minor: Sustainable Environment

Minor will be offered to: - Computer/IT, Electronics/EXTC, Electrical, Mechanical, Production, Civil, Textile

Sr. No.	Name of the Course	Brief Curriculum
1	Principles of Sustainability	**Concept of sustainability:** Definition of sustainability, three pillars of sustainable development, environmental, social, and economic aspects of development, interconnectivity of people, planet, and prosperity aspects. **Sustainable Development Goals:** Millenium development goals, formulation of sustainable development goals, indicators for various sustainability goals, sustainability index and associated targets. **Ecosystem services:** Understanding various ecosystem services, effect of industrialization on ecosystem services, impact of climate change. **Sustainability in supply chain:** Understanding sustainable supply chain management, sustainability reporting and associated standards, national and global legislations associated to sustainable reporting. **Principles of green chemistry:** Definition of green chemistry, 12 principles of green chemistry, resource recovery, environmentally sound reject management practices. **Engineering applications of sustainability principles:** Applications of sustainability principles to engineering projects, sustainable product design, innovative thinking and optimum resource management.
2	Water and Wastewater Management	Characteristics of water and wastewater: Physical, chemical, and biological characteristics of water and wastewater, drinking water standards in India (IS10500-2012), treated wastewater discharge standards, water quality index. Water treatment processes: Design of unit processes used for water treatment such as aeration, sedimentation, filtration, and chlorination, developing water treatment scheme for ground water and surface water. Wastewater treatment processes: Design of unit processes used for wastewater treatment such as screening, coagulation and flocculation, biological treatment, filtration, and adsorption, developing wastewater treatment scheme for domestic wastewater. Resource recovery: Understanding efficient water and wastewater management, resource recovery from waste streams, concepts of reuse and recycle. Industrial effluent treatment: Effluent characteristics for ‘red category’ industries, treatment units used for industrial effluent treatment, effluent management for major polluting industries. Zero Liquid Discharge: Definition of Zero Liquid Discharge (ZLD) systems, tertiary treatment units and reject management systems, advantages and disadvantages of ZLDs, case studies on sectors implementing ZLD regulations.

3	Environmental Economics	Introduction to Environmental Economics: Meaning, Definition, and Relevance of Environmental Economics; Basic Concepts and Tools from Microeconomics and Welfare Economics; Comparison with Other Sub-disciplines like Ecological, Economics, and Natural Resource Economics; Major Problems and Key Concerns of Environmental Economics. Commons and Collective Actions Problem: Seminal Theories; Mancur Olson's Theory of Collective Action; Collective Action and Prisoner's Dilemma Game. Environment and Economic Growth: Poverty, Environment and Economic Growth Linkages-Environmental Kuznets Curve, Environmental Sustainability; Environmental Performance Index; Benefit-cost Analysis. Consumer Demand for Environmental Goods: Consumer Demand for Environmental Goods and Welfare Effects of Price Change; Values, Environmental Values, and Non-market Valuations: Revealed Preference Methods, Stated Preference Methods. Market-efficiency, Optimality, Consumers and Producers Surplus. Public Market and Environment: Optimal Provision of Public Goods and Bads; Externality and Market Failure; Pigouvian Fee, Property Rights and Coase Theorem. Environmental Acts and Regulations: Environmental Regulations and Basic Regulatory Instruments-Market-based Instruments/ Approaches; Environmental Regulation and Basic Regulatory Instruments-Market Trading Systems.
4	Air and Noise pollution control engineering	Fundamentals of Air Pollution and Noise Pollution Composition of dry ambient air, properties of air, Definition of air pollution, Classification of air pollutants, Units for classification of air pollutants, History of air pollution- global and national, Scope of problem-general, urban, rural, and specific. Noise: Basic concept, measurement, various control methods. Sources of Air Pollution and Its Effects Sources of air pollution: Natural and man-made, Major pollutants from different sources in Greater Mumbai area and other Indian cities, Emission factors. 3. Effect of air and noise pollution on human health, plants, animals, properties, and visibility, CoH, CoHb Meteorology and Air Pollution Dispersion Meteorological aspects of air pollution, large-scale wind circulation including geostrophic wind and gradient wind, influence of cyclones, anticyclones, planetary boundary layers, lapse rate, and stability conditions, wind velocity profile and maximum mixing depth, topographic effects and their role in pollutant dispersion, types of plume patterns and their significance in air quality assessment Air Quality Monitoring and Standards Methods and instruments for stack and ambient air monitoring, sampling and analysis techniques for gaseous and particulate pollutants, principles of isokinetic sampling and continuous monitoring, particle size analysis and mass analysis, Government of India’s air pollution acts and laws, Indian emission and air quality standards, noise standards, amendments in air pollution laws, IS standards for ambient air quality and industrial emissions. Air Pollution Control Devices – Principles and Design Design and operation of air pollution control devices, hoods and ducts including hood specifications and design considerations, duct design and ventilation by dilution, settling chambers for dust removal in laminar and turbulent flow, economic sizing and efficiency considerations, inertial devices such as cyclones for particulate collection, factors affecting efficiency, pressure drop and power requirements, economic sizing of cyclones. Advanced Control Technologies and Filtration Systems Electrostatic precipitators (ESP) including collection efficiency, electric field principles, particle charging mechanisms, effects of temperature and dust resistivity on collection efficiency, pressure drop, power requirement, sizing, and costing, particulate scrubbers

		including interception, impaction, collection efficiencies, design criteria for cyclone and Venturi scrubbers, filtration systems such as bag filters and baghouses, fabric filtration theory, collection efficiency, pressure drop, design considerations, sizing, and costing of filtration units.
5	Climate Change and Adaptation	The climate system, and interaction among the sub-systems, Earth's natural greenhouse Effect and Dark Heating, radiation balance, Climates of the past, natural versus anthropogenic causes of climate change, enhanced greenhouse effect, climate forcing, Runaway greenhouse effect, CO_2 emissions and the Earth's carbon reservoirs, The Intergovernmental Panel on Climate Change (IPCC), Weather and climate, Global wind systems, importance of monsoons, El-nino and southern oscillations, general global circulation, Understanding the Social Theory of Climate Change, Recent Climate change-human intervention, emission scenarios/pathways, Changes in climate extremes, long and short term climate changes, regional patterns of climate change, temperature response, air quality response, irreversibility, tipping point and abrupt changes, Climate change impacts on: fresh water resources-surface and groundwater, drought and soil moisture, wetlands, glaciers melting, terrestrial ecosystem-geographic shifts in terrestrial habitats, vegetation-climate interaction, loss of biodiversity, agriculture and food supply, marine environment- sea level rise, ocean current and circulation, ocean acidification, coastal lives, marine ecosystem, Adaptive capacity, adaptation to climate change, Carbon sequestration, Mitigation technologies and potential in 2030, Zero carbon future, temperature stabilization, mitigation- carbon dioxide removal, Climate change preparedness.

7.Title of the Minor: Minor in Industrial Engineering and Operations Research (IE and OR)

Minor will be offered to: Other than Production Engineering Students

Sr. No.	Name of the Course	Brief Curriculum
1	Basics of Industrial Engineering	Introduction to Industrial Engineering; product design and development; work study (method study and work measurement); ergonomics and human factors; production planning and control (PPC); plant layout; facility location; materials and inventory management; basics of quality control, reliability engineering, and safety management. Students will understand and apply foundational IE concepts to improve efficiency in manufacturing and service systems.
2	Operations Research	Fundamentals and advanced topics in OR: linear programming, duality, sensitivity analysis, transportation and assignment models, integer and nonlinear programming, game theory, queuing models, and simulation techniques. Emphasis on modeling and solving decision problems in engineering and management using tools like Excel Solver or Python. Students will be able to model and solve real-world optimization problems using OR techniques.
3	Fundamentals of Industrial Hydraulics and Pneumatics	Principles of fluid power systems; components such as valves, pumps, actuators; system design for hydraulic and pneumatic circuits; regenerative and hybrid systems; electro-hydraulic controls; troubleshooting and maintenance; applications in automation and robotics. Students will gain the ability to design and analyze basic hydraulic and pneumatic automation systems.
4	Industrial Instrumentation	Overview of measurement systems; transducers and sensors for displacement, temperature, pressure, flow, level, pH, etc.; signal conditioning and data acquisition; smart sensors and IoT integration; instrumentation for control systems; calibration and industrial case studies. Students will be able to select and integrate appropriate sensors and instrumentation in industrial applications.

5	Industrial Automation and Control	Automation architecture; control strategies (P, PI, PID tuning); PLC programming and ladder logic; SCADA and HMI systems; CNC and robotic integration; pneumatic and hydraulic automation; energy-efficient drives; Fieldbus, Profibus, and Ethernet/IP; overview of IIoT, cybersecurity in automation, and digital twin concepts. The course also introduces AI/ML applications such as predictive maintenance, quality inspection using machine vision, adaptive process control, and anomaly detection in industrial automation. Students will learn to design and implement automation and control systems using industry-standard tools and techniques, including AI/ML-based intelligent control and monitoring.

8.Title of the Minor: **Data Science**

Minor will be offered to: - **Electronics/EXTC, Electrical, Mechanical, Production, Civil, Textile**

Sr. No.	Name of the Course	Brief Curriculum
1	Introduction to Data Science.	• Introduction to Data Science, Different Sectors using Data science, Purpose and Components of Python in Data Science. • Data Analytics Process, Knowledge Check, Exploratory Data Analysis (EDA), EDA-Quantitative technique, EDA- Graphical Technique, Data Analytics Conclusion and Predictions. • Feature Generation and Feature Selection (Extracting Meaning from Data). Feature Selection algorithms. • Data Visualization- Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects • Applications of Data Science, Data Science and Ethical Issues- Discussions on privacy, security, ethics, A role of data scientist.
2	Python for Data Science and Data Analysis.	• Basics of Python including data types, operators, variables, expressions, control structures using sample dataset, objects and functions. Python sequence data structures including String, Array, List, Tuple, Set, and Dictionary, hashes. • Data Analysis libraries: Using Pandas ,Data Frames, Numpy multi-dimentional arrays, and SciPy libraries to work with a various dataset. • Exploratory data analysis :Data preprocessing (data loading, dealing with missing values and outliers, data wrangling, filtering data, Data Normalization , Data Formatting ,data cleaning), • More APIs relevant to Data Processing.
3	Introduction to ML with python	• Introduction – Types of learning - Essential Libraries and Tools - scikit-learn - NumPy - SciPy - matplotlib – pandas and editors. • Data Pre-processing, data cleaning and for mating, Feature extraction for supervised and unsupervised learning. • Supervised Learning – Regression - Linear Regression, Logistic Regression , Classification - Nearest- Neighbours, Decision Trees, Naive Bayes, SVM. • Unsupervised Learning and Pre-processing - Challenges in Unsupervised Learning - Pre-processing and Scaling - Different Kinds of Pre-processing - Applying Data Transformations -Scaling Training and Test Data. Clutsering Algorithms and Evaluation of algorithms. • Evaluating Machine Learning algorithms and Model Selection - Cross-Validation - Cross-Validation in scikit-learn – Types and Benefits of Cross-Validation.

4	Data Visulization and Processing Tools	• Data import and visualization, Introduction to various plots: Implement data visualization techniques and plots using Python libraries, such as Matplotlib, Seaborn • Create different types of charts and plots such as line, area, histograms, bar, pie, box, scatter, and bubble. • Corelation Visualization and Analysis. • Dimentionality Reduction Algorithms. PCA Analysis. • APIs for advanced processing for various learning models.
5	Web Data Mining	• Data Mining Foundations, Association Rules and Sequential Patterns, Basic Concepts of Association Rules, Apriori Algorithm, Frequent Itemset Generation, Association Rule Generation, Data Formats for Association Rule Mining. • Link Analysis, Social Network Analysis, Page Rank Algorithm, Web Crawling, A Basic Crawler Algorithm – Breadth First Crawlers, Preferential Crawlers, Implementation Issues – Fetching, Parsing, Stopword Removal, Link Extraction, Spider Traps, Page Repository, Universal Crawlers, Focused Crawlers. • **C**oncepts of Information Retrieval, IR Methods, Vector Space Model , Web Page Pre-processing, Stopword Removal, Stemming, Web Page Preprocessing, Duplicate Detection, Inverted Index, Query and Retrieval, Web Search, Meta Search. • Web Usage Mining, Data Collection and Preprocessing, Sources and Types of Data, Key Elements of Web Usage Data Preprocessing, Data Modeling for Web Usage Mining, Discovery and Analysis of Web. Case studies such as Opinion Mining, Sentiment Classification, Usage Patterns, Session and Visitor Analysis, Cluster Analysis and Visitor Segmentation, Analysis of Sequential and Navigation Patterns.

9..Title of the Minor: AI ML

Minor will be offered to: - Electronics/EXTC, Electrical, Mechanical, Production, Civil, Textile

Sr.No	Name of the Course	Brief Curriculum
1	Introduction to AI & Machine Learning	Defining Artificial Intelligence, Defining AI techniques, Using Predicate Logic and Representing Knowledge as Rules, Representing simple facts in logic, Computable functions and predicates, Procedural vs Declarative knowledge, Logic Programming, Mathematical foundations: Matrix Theory and Statistics for Machine Learning.
2	Introduction to Data Analytics.	Introduction to Data Science, Different Sectors using Data science, Purpose and Components of Python in Data Science. Data Analytics Process, Knowledge Check, Exploratory Data Analysis (EDA), EDA- Quantitative technique, EDA- Graphical Technique, Data Analytics Conclusion and Predictions. Feature Generation and Feature Selection , Data Visualization.
3	Deep Learning and Neural Network	Information flow in a neural network, understanding basic structure and ANN. Training a Neural network, how to determine hidden layers, recurrent neural network. Convolutional neural networks, image classification and CNN. RNN and LSTMs. Applications of RNN in real world.
4	Special topics in Artificial Intelligence	Bayesian Filtering; Recurrent Neural Networks, Deep Neural Networks, Deep Reinforcement Learning. Self-Play Networks, Generative Adversarial Networks, Learning from Concept-Drifting Data Streams. Audio Signal Processing Basics, An introduction to neurocomputing and its possible role in AI.
5	Applications of AI	Linguistic aspects of natural language processing, A.I. And Quantum Computing, Applications of Artificial Intelligence (AI) in business. Emotion Recognition using human face and body language, Robotic Processes Automation for supply chain management. AI-Optimized Hardware, Digital Twin i.e. AI Modelling

10.Title of the Minor: MINOR IN ELECTRIC VEHICLES

Minor will be offered to:- All disciplines

Sr. No.	Name of the Course	Brief Curriculum
1	ELECTROMECHANICAL ENERGY CONVERSION	This course introduces the principles of electromechanical energy conversion, focusing on the fundamental concepts necessary for understanding electric vehicles (EVs). Topics include the basics of electromagnetic fields, Faraday's Law of Induction, and the operation of electromechanical devices such as transformers, generators, and electric motors. Students will learn about different types of electric motors used in EVs, including DC motors, induction motors, and permanent magnet motors.
2	CONVENTIONAL VEHICLES AND COMPONENTS OF ELECTRIC VEHICLES	This course provides an overview of conventional internal combustion engine vehicles and their key components. Topics include the fundamental principles of engine operation, fuel systems, transmission, and exhaust systems, etc. Students will learn about the various subsystems that make up a traditional vehicle, including braking, steering, and suspension systems. Comparisons between conventional and electric vehicles will be drawn to highlight the differences and the motivations for transitioning to electric vehicles. Architecture of EVs, including electric motors, power electronics, onboard chargers, and inverters. The course covers the role of regenerative braking systems and how they improve efficiency. Students will also learn about thermal management systems and their importance in maintaining optimal performance and safety. Case studies and simulations will help students understand the integration and operation of these components in real-world EVs.
3	BATTERY MANAGEMENT SYSTEM	This course covers the crucial role of battery management systems (BMS) in electric vehicles, covering the principles and technologies involved in managing and optimizing battery performance. Topics include battery chemistry, charging and discharging cycles, state of charge (SOC) and state of health (SOH) estimation, and thermal management. Students will learn about the design and implementation of BMS, including protection mechanisms, balancing techniques, and communication protocols. The course will also provide insights into the challenges and solutions in BMS, ensuring the safe and efficient operation of EV batteries.
4	HYBRID ELECTRIC VEHICLES	This course introduces the concepts and technologies behind hybrid propulsion systems that combine internal combustion engines with electric powertrains. Topics include the different types of hybrid configurations (series, parallel, and series-parallel), energy management strategies, and the advantages and challenges of hybridization. Students will study the components unique to HEVs, such as power split devices and regenerative braking systems. Case studies and practical examples will illustrate the real-world applications of HEVs.
5	SOCIO-ECONOMIC IMPACT OF EV	This course explores the broader implications of electric vehicle (EV) adoption on society and the economy. Topics include the environmental benefits of EVs, such as reductions in greenhouse gas emissions and pollution. Students will examine the economic impact, including job creation in the EV industry, changes in the automotive market, and the effects on oil dependency. The course also addresses the challenges and opportunities in the transition to EVs, such as infrastructure development, government policies, and consumer acceptance.

11.Title of the Minor: Entrepreneurship development, business communication, business development and management (Entrepreneurship & Startups)

Minor will be offered to: - Computer/IT, Electronics/EXTC, Electrical, Mechanical, Production, Civil and Textile

Sr. No	Name of the Course	Brief Curriculum
1	Orientation Programme in Entrepreneurship	Module-I: **Introduction to Entrepreneurship** Meaning and concept of entrepreneurship, the history of entrepreneurship development, role of entrepreneurship in economic development, Myths about entrepreneurs, agencies in entrepreneurship management and future entrepreneurship types of entrepreneurs. Module-II: **The Entrepreneur** Why to become an entrepreneur, the skills/ traits required to be an entrepreneur, Creative and Design Thinking, the entrepreneurial decision process, skill gap analysis, and role models, mentors and support system, entrepreneurial success stories. Module-III: **E-Cell** Meaning and concept of E-cells, advantages to join E-cell, significance of E-cell, various activities conducted by E-cell Module-IV: **Communication** Importance of communication, barriers and gateways to communication, listening to people, the power of talk, personal selling, risk taking & resilience, negotiation Module-V: **Introduction to various form of business organization** (Sole proprietorship, partnership, corporations, Limited Liability company), mission, vision and strategy formulation.
2	Exploring Business Opportunity	Module-I: **Self-Discovery** Natural born entrepreneur, the reluctant entrepreneur, the hidden traits, discovers your own strength. Module-II: **Idea Generation** Sources of business ideas, how to find & assess ideas? Where to find data for ideation? What is a good problem? Opportunity recognition. Module-III: **Idea Evaluation** Design thinking for finding solutions, prototyping, idea evaluation, entrepreneurial Outlook, value proposition design, customer insight, ideas development , capstone project presentation. Module-IV: **Feasibility Analysis** Product/Service Feasibility Analysis, Industry & competition analysis, environment analysis, financial feasibility analysis.
3	Developing a Business Model	Module-I: **Team** Finding your team, art of team formation, teamwork planning, chief mentor/ founder & Co founders, team formation, and delegation of work. Module-II: **Preparation of Business model/Plan** Meaning and significance of a business plan, components of a business plan, and feasibility study, Iterating the MVP, Digital Presence for Ventures, Clarifying the value proposition, Guidelines for writing BP, pre- requisites from the perspective of an investor. Module-III: **Business Model** The importance and diversity of business models, how business models emerge, potential fatal flaws of business models, components of an effective business model, core strategy, strategic resources, partnership network, customer interface. Module-IV: **Product/ Market Fit** Understanding basics of unit economics, cost and profitability, Refining the product/service, Establish the success and operational matrix, Starting Operations. Customer Validation: Evaluate the efficiency with which customers can be captured and kept, Early insights on cost of customer acquisition, Other Stakeholder Validation, Customer Development and Experience.

4	Translating Business Model Into Start-up	Module-I: **Gaining marketing Intelligence** Identify the vertical you will operate in and the business opportunity, understand your customers and accurately assess market opportunity, minimum viable product and the lean method. Module-II: **Develop and validate business model for your venture** Value Proposition, Customer Segments, Channels and Partners, Revenue Model and Streams, Key Resources, Activities, and Costs Customer Relationships and Customer. Module-III: **Development Processes** Translate Business Model into a Business Plan, Visioning for venture, Take product or service to market, Deliver an investor pitch to a panel of investors, Identify possible sources of funding for your venture – customers, friends and family, Angels, VCs, Bank Loans and key elements of raising money for a new venture. Module-IV: **Business Plan & Startup-I** Get to market Plan, Effective ways of marketing for start-ups – Digital and Viral Marketing; Hire and Manage a Team, Managing start- up finance: The Concept of Costs, Profits, and Losses, Manage your Cash Flow, analyse your Financial Performance, budgeting. Module-V: **Business Plan & Startup-II** Establishing an ethical culture for a firm, Legal and regulatory aspects for starting up specific to your venture, Enhancing the growth process and creating scalability (customers, market share, and/or sales), Thorough understanding of market size, costs, margins, delivery channels, customer acquisition costs, Identify areas to build efficiency (product making, service delivery, and channels - key areas of the BM Canvas are identified by now), Finalize business model and plan, Have a 1-2 year roadmap and trajectory. Module-VI: **Obtaining Business Licenses and permits** Business Licenses, business permits, choosing a form of business organization, sole proprietorship, partnership, corporations, Limited Liability company.
5	Entrepreneurship: Growth	Module-I: **Growth Opportunities** Characteristics of high growth new ventures, strategies for growth, and building the new venture capital, discovering and assessing opportunities for growth, developing a growth mind-set and visioning for growth, review the robustness and relevance of business model vis-à-vis current market situation, map financing decisions to business models and reiterating business models Module-II: **Retention & Expansion Strategies** Characteristics of high growth new ventures, strategies for growth, and building the new venture capital, discovering and assessing opportunities for growth, developing a growth mind-set and visioning for growth, review the robustness and relevance of business model vis-à-vis current market situation, map financing decisions to business models and reiterating business models Module-II: **Retention & Expansion Strategies** Dealing with stagnation of customer base and developing customer base: expansion to new markets –options and strategies, product Life Cycle – Product Road Map; Getting to Plan B, project to Process: Build, adapt, test, and establish key processes and systems that enable efficiency, continuous and sustained innovation Module-III: **Developing the organizational capabilities for growth** Develop strong leadership capabilities, ability to delegate and manage key leadership tasks. o Streamline operations and organizational design to accommodate growth, Implement new and effective approaches to marketing and communication for customers, suppliers, and employees, Acquire new resources for strategic growth: executive hires. Module-IV: **Planning and streamlining financial/ Legal processes** Managing cash for growth, Balance between profitability and growth costs, Role of business services –accountant, lawyer, Understanding legal requirements, and compliance issues, Exit options :Evaluating opportunities for acquisition; Growth financing, Scalability & efficiency improvements, IPR.

6	Entrepreneurship Expansion	Module-I: **Expansion model** Geographical/Franchising/Licensing routes to new market expansion Module-II: **Maximizing Profits** Testing price elasticity, Cost reduction through scaling up, Expanding offerings, other revenue streams (partnerships) Module-III: **Renewal** Similar to Take-off and Resource Maturity of SMEs Module-IV: **Harvesting Rewards** Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy

12.Title of the Minor: MINOR IN MANAGERIAL ECONOMICS AND IPR IN MANUFACTURING SECTOR

Minor will be offered to:- All disciplines

Sr. No.	Name of the Course	Brief Curriculum
1	Elements of Business Management in Manufacturing sector	Overview of manufacturing sector, nature of business management, Management principles, Types of capital for micros, small, medium and large scale industries and start ups.
2	Sem IV –Cost economics in manufacturing	Types of costing, Break even analysis, Profitability, Appraisal of business, Variance costing etc.
3	Retail & Supply chain management	Distribution channels and logistics in manufacturing sector, Retail operation and retail pricing, understanding international business, strategic cost management
4	Certification & Sustainability compliances in manufacturing sector	Environmental Legislations in manufacturing sector, International and National policy regarding certification, Environmental auditing, eco-labeling-for manufacturing sector
5	Innovation - New Product Development & IPR	Role of innovation in business development, concept of 'concurrent engineering', phases of product development, concept of 'Design Review', Failure modes and Effect analysis, Capturing values by protecting innovation, types of Intellectual Property rights and Patent protection strategies

13.Title of the Minor: MINOR IN FUNCTIONAL AND SMART MATERIALS

Minor will be offered to:- Computer/IT, Electronics/EXTC, Electrical, Mechanical, Production, Civil

Sr. No.	Name of the Course	Brief Curriculum
1	Polymers & Raw materials for Engineering applications	Material engineering and role of raw materials in product development, types of polymers and other high performance materials
2	Manufacturing of flexible substrates	Processes and production techniques for making flexible substrates, development of 2 D and 3 D planer structures
3	Flexible materials for infrastructure, architecture and outdoor structures Role of geotextiles	Development of non-metallic structures for soil stabilisation and soil erosion control, flexible and composite structures in landfills, Design & development of reinforcement and embankment structures. Development of flexible coated and composite weather resistant structures for Industry, airport, Sports stadiums etc., awnings and canopies, development of structural composites for facades and outdoors.
4	Smart structures for protective applications	piezoelectric materials, high performance fibers, phase change materials, shape memory fibers, Sensors and barriers for protection, personal protective equipment, nanomaterials in protection.
5	Quality control and sustainability in functional & Smart Structures	Testing and evaluation of functional materials, Norms for eco-testing and sustainability certification for Smart Materials & Structures.

14. Title of the Minor: MINOR IN INTERNET OF THINGS

Minor will be offered to:- All branches excluding Electrical, Electronics and Electronics & Telecommunication

Sr. No.	Name of the Course	Brief Curriculum
1	BASICS OF ELECTRONIC CIRCUITS	This course introduces the foundational concepts of electronic circuits essential for IoT systems. It covers diode-based circuits including rectifiers, clippers, clampers, Zener diodes, LEDs, and photodiodes. It then explores Bipolar Junction Transistors (BJTs) and their use in amplifier and switching circuits, followed by FETs and MOSFETs with similar applications. The course also includes differential amplifiers and operational amplifiers (Op-Amps) with practical circuits such as inverting, non-inverting amplifiers, adders, subtractors, integrators, and differentiators. Emphasis is placed on both DC and AC circuit behavior, equipping students with core electronic skills needed for real-world hardware interfacing and IoT system design.
2	DIGITAL ELECTRONICS	This course introduces the core principles of digital electronics, crucial for designing logical control systems in IoT. It begins with number systems, binary arithmetic, and basic logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR) along with their truth tables. Students then study Boolean algebra, its theorems, and logic simplification techniques using Karnaugh Maps. The course continues with the design of combinational logic circuits such as comparators, code converters, multiplexers, demultiplexers, encoders, decoders, and binary adders/subtractors. It concludes with sequential logic systems, covering latches and flip-flops (SR, JK, D, T, Master-Slave), which are fundamental to memory and timing operations in digital systems.
3	SENSORS AND TRANSDUCERS	This course covers types and characteristics of transducers and sensors, including resistive, capacitive, inductive, elastic, and active types. It introduces conventional and smart sensors, their principles, applications, and selection criteria for electronic systems and IoT.
4	PRINCIPLES OF IOT	This course introduces IoT concepts, components, and architecture. It covers IoT standards, protocols, and wireless sensor networks. Students learn about sensors, actuators, and open hardware like Arduino and Raspberry Pi. The course includes IoT software platforms (e.g., AWS, Azure, Node-RED) and concludes with prototyping IoT applications using real-world examples and APIs.
5	INDUSTRIAL IOT	IoT enables predictive maintenance of machinery and optimization of manufacturing processes.It Focuses on smart grid technology, efficient energy distribution, and wireless communication systems. It Facilitates smart city initiatives, infrastructure monitoring, and traffic management systems. Involves the development of robust, secure networks and efficient data processing algorithms. IoT applications are in process automation, real-time monitoring of chemical plants, and safety management.

15. Title of the Minor: MINOR IN SIGNAL PROCESSING AND IMAGING

Minor will be offered to:- CS, IT, Civil, Production, Mechanical, Textile and other Non-circuit Engineering branches

Sr. No.	Name of the Course	Brief Curriculum
1	SIGNALS AND SYSTEMS	This course introduces CT and DT signals, system classification, impulse response, and convolution. It covers Z-transforms, their properties, and system realization using FIR/IIR models. Students learn difference equations, convolution methods, and stability analysis. The course ends with frequency domain analysis using pole-zero plots and system classification based on frequency and phase response.
2	DIGITAL SIGNAL PROCESSING	This course covers linear phase FIR systems, DFT and FFT techniques, FIR filter design using windows and frequency sampling, and IIR filter design using analog approximations and transformations.
3	DIGITAL IMAGE PROCESSING	This course introduces image processing fundamentals including image acquisition, digitization, and color models. It covers various image transforms (DFT, DCT, Wavelet), image enhancement techniques (histogram equalization, filtering), and image segmentation methods (edge detection, clustering, morphological operations). It also addresses image compression concepts and standards like JPEG and JPEG2000. Applications focus on real-world engineering and design problems.
4	PATTERN RECOGNITION	This course focuses on applying pattern recognition techniques to signal processing problems. It begins with the fundamentals of pattern recognition systems and their role in signal classification. Key topics include Bayesian decision theory for signal categorization, Gaussian models for signal distribution, and parameter estimation techniques. It emphasizes unsupervised learning (e.g., K-means clustering) for analyzing signal features and uses PCA for reducing signal data dimensionality. The course concludes with Hidden Markov Models (HMMs), widely used in speech, biomedical, and sequential signal pattern analysis
5	APPLICATIONS OF SIGNAL AND IMAGE PROCESSING	Vibration analysis for machinery health monitoring. Remote sensing for structural health and environmental monitoring. Enhancing communication systems through noise reduction and data compression. Medical imaging techniques such as MRI and ultrasound for diagnostics. Real-time image processing for immersive experiences in Virtual Reality. Image enhancement and restoration in digital forensics. Deep learning for image classification and segmentation. Develop textiles with integrated signal processing for health monitoring or environmental sensing. Use of ultrasonic and X-ray signals to assess product integrity without damage. Identifying anomalies in production processes through signal analysis.

16. Title of the Minor: MINOR IN CYBERSECURITY

Minor will be offered to: - Electrical Engineering Students only

Sr. No.	Name of the Course	Brief Curriculum
1	FUNDAMENTALS OF CYBERSECURITY	This course introduces the core concepts of cybersecurity. It begins with security goals, types of cyberattacks (passive, active, web, email), OSI security architecture, and malware (viruses, worms, trojans). It then covers cybercrimes and the Information Technology Act, 2000, including digital signatures and electronic evidence. Students learn number theory fundamentals like modular arithmetic and prime numbers, which are foundational for encryption. The course concludes with traditional symmetric-key ciphers, including substitution and transposition techniques, stream/block ciphers, and classical encryption methods like the Hill and Playfair ciphers.
2	MODERN CRYPTOGRAPHY	This course covers advanced cryptographic techniques essential for secure communication. It begins with symmetric-key cryptography, focusing on block cipher design, DES, and AES algorithms. Next, it introduces asymmetric-key cryptography, including RSA, Diffie-Hellman, and Elliptic Curve Cryptography (ECC). The course then covers message integrity and authentication, using hash functions (SHA), HMAC, DAA, and CMAC. It concludes with digital signatures and key management, discussing standards, digital certificates (X.509), and protocols like Kerberos.
3	NETWORK SECURITY	This course introduces the principles and threats related to network security. It covers network security models, attacks on the TCP/IP suite, and real-time communication security. Students learn about IP and email security, including SSL/TLS, PGP, and firewall configurations. It addresses network vulnerabilities such as DoS, spoofing, man-in-the-middle attacks, and defense tools like NIDS and firewalls. The course also explores web security (e.g., SQL injection, XSS) and wireless network security, including threats like WEP vulnerabilities and methods for securing adhoc and sensor networks.
4	IOT AND CLOUD SECURITY	This course covers security principles for IoT and cloud environments. It begins with IoT and cloud architecture, service models (IaaS, PaaS, SaaS), and design principles like encryption and layered defense. Students study vulnerabilities and attack surfaces in IoT/cloud systems, and trust models including authentication and privacy frameworks. It explores secure communication, network protocols, and back-end data protection in IoT. The course concludes with cloud security controls for IoT and hands-on penetration testing, using tools for scanning, exploitation, and interface debugging.
5	ETHICAL HACKING AND DIGITAL FORENSICS	